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THE UTILITY OF ELECTRIC SEARCH LIGHTS.

THERE is naturally much difference of opinion as to the way naval battles of the future are likely to be fought, but experts seem to be agreed, that at the next fleet action torpedoes and torpedo boats will be very largely used as a means of attacking, perhaps fatally, the huge monitors which represent the naval architecture of the latter end of the nineteenth century. Consequently it has, of late, been considered a question of sovereign importance how men-of-war can best be protected against these diminutive agents of destruction. In the daytime a modern man-o'-war, with her splendid armament of machine and quick-firing guns, ought to be able to keep even a large fleet of torpedo boats at a distance; indeed it is unlikely that the latter would risk an encounter under such unfavourable conditions. But after sunset the case is different, and unless the big ship be amply protected there can be little question as to what would be the termination of the encounter. The introduction of electric search lights on such an extensive scale into the Royal Navy clearly shows how keenly the danger was appreciated by those responsible for the maintenance of our maritime supremacy. With this innovation the relative chances of the torpedo and the floating leviathan have been equalised, for however small and flitting the target may be the machine guns, aided by powerful search lights, would do inestimable damage in a very short time, or at any rate prevent the near approach of the wily intruder. Defence nets are doubtless very efficacious, but with this kind of protection all sorts of pranks might be played if an approaching enemy were not subjected to the full glare of a most brilliant and penetrating light. The part which search lights would inevitably play in connection with torpedo warfare has been pretty clearly demonstrated by the attacks which were made last week by Captain Long and his flotilla on the fleets at Spithead and Portland. In the former instance Captain Long dropped several torpedoes near the flagship *Minotaur* (which, with the *Black Prince* and *Agincourt*, was singled out for attack as it had no net defences) but it is very questionable whether he would have been enabled to do so in actual warfare in face of the withering fire from the machine guns to which he was exposed. With consummate skill Captain Long divided and sub-divided the craft at his disposal, and the attack was made almost simultaneously from different quarters. As a kind of blind the *Rattlesnake*, torpedo vessel, in the guise of a peaceable merchantman, was sent boldly down the lines, but her true mission was quickly detected, and such a blaze was showered upon her that the officers and men on board were completely dazzled, and in actual warfare the ship would have been sent to the bottom in the space of a few minutes. Advantage was taken of the attention which was being bestowed on the *Rattlesnake* to push forward the torpedo boats, but they were soon seen, and as they dodged and manœuvred at a very high speed for nearly an hour the fleet guns were continually blazing away. Eventually matters became much too warm for Captain Long, who put into the harbour, foiled in his attempt to surprise the fleet. In future the Admiralty would do well to increase, if possible, the number of search lights carried by big vessels, and to fit every fighting ship in the navy with such an important means of protection.

ELECTRICAL TENDERS.

THE curiosities of tendering have frequently received notice in periodicals which deal particularly with contract work, but it is not often that electrical tenders come under discussion for their eccentricity or for any other reason. Not but what, probably, if one could see all the tenders sent in for various classes of work by electrical firms, many interesting and even surprising points would frequently be presented; but it is a somewhat singular fact that electrical tenders are rarely published, so that a comparison between highest and lowest is seldom possible. A few weeks ago, however, we were able to publish the tenders sent in for effecting certain alterations in the electric lighting installation at the Brighton Pavilion; in that instance, the highest estimate was about three times greater in amount than the lowest. We asked at the time how so great a difference in the estimates of two presumably respectable firms could be possible. We have now to repeat the query in connection with another instance of great variation in the amounts of tenders for certain work of well-known character. A little while ago the Hornsey Local Board advertised for tenders for the erection of street fire alarms and the carrying out of electric communication throughout its district. Eighteen tenders were received, such well-known firms competing as Siemens, Reid Bros., the Exchange Telegraph Company, Sax, the India Rubber Company, the Telegraph Manufacturing Company, and others. The highest amount given as an estimate of the cost of the work was £1,385, by Radcliffe, of Birmingham, who was willing to maintain the system in working condition for £100 per annum. The remaining tenders varied in amount down through the hundreds until, at the bottom of the list, we find Blenheim, of Egham, contracting to do the work for £420, and to maintain the system in operation for £10 per annum. Mr. Blenheim must either have the most confident belief in the stability of his work, once performed, even at so cheap a rate, or must be ignorant of the risk he runs in regard to the repair of a system so prone to get out of order and to sustain damage as street fire alarms. His tender, at any rate, has been accepted; but seeing the enormous differences

between the various tenders, we should be surprised if the Hornsey Local Board does not take particular care to assure itself that it will get the thing it wants. An obvious suggestion when such discrepancies are found is that at least a portion of the fault should be allotted to the specifications, which must have been in some sense vague; but it is difficult to believe that those documents could unintentionally be drawn up in a manner so misleading as to account for the differences between £1,385 and £420, £100 and £10. We confess the subject is something of a mystery to us: perhaps some of our readers possess a clue which might lead to its solution.

IT is to be hoped that some time before the close of the century electricians will fully understand the meanings of the terms they use. A few weeks ago we had to call attention to the unnatural combination invented by Mr. Sprague, and called by the comprehensive name of *volt-ohm-ampère-second*; now we have Mr. Fricker talking in the *Electrician* of the electrical loss in an armature as so many "*watts per second*" (*sic*). What in the name of things electrical is a watt per second, and when will it be realised that the watt is not a *quantity*, but *the unit rate at which electric energy is generated?* The expression "watts per second" has no physical meaning, and can only be equalled in absurdity by some such phrase as "1,000 revs. per minute per hour." We did think that the difference between a "joule" and a "watt," between a quantity and a rate, would have been comprehended ere now.

AMERICA is a big place, and there one new dynamo and one new motor, at least, are brought out and illustrated every week. But it may be questioned whether the endless variety of design shows any real advance, and judging from the descriptions given in our contemporaries we should say that the designers are now experimenting to find out what we have known for some years. Be this as it may, here is something really startling, which we cull from the *New York Electrical World*. A Mr. Silvey invented, designed or caused to be constructed a certain dynamo. The magnets of this dynamo consisted of a cast-iron ring with six projecting wedge-shaped pole pieces, the magnet coils being wound between these, and the whole thus forming a six-pole field with alternate N. and S. poles. If we read the description aright, the armature was a Pacinotti ring, having six projections corresponding to the six pole pieces, and the coils were six in number, wound between those projections. The armature was of the open circuit class, and changed polarity six times per revolution, but when first tried it evinced great tendency to spark at the brushes. The startling part, which may be quite true and perfectly explicable, is as follows:—To overcome this fault, *after the armature was wound with its conductors, there were wound over it three layers of iron wire, each entirely encircling the armature, covering up the coils, and thus coming in direct contact with the poles on the armature. With this addition, simple as it may seem, the output of the machine was increased at least 70 per cent. and the sparking entirely overcome.*

UPON the subject of our reference to his name in connection with the matter of the "Eclipse" battery last week, Prof. Thompson assures us that until the morning of August 15th, when he saw it at our office, he was not aware that his private note of March 23rd had been printed, or that copies of it had been put into circulation, and he is positive that no such copy accompanied the prospectus of the Eclipse Battery Company which he received by post on Monday, August 8th. Furthermore, it was not until he received the documents accompanying the Eclipse Battery Company's prospectus, on August 8th, that he became aware (by reading the reprinted extracts from the Press) of the manner and extent to which his name had been used in the daily press during the preceding month, the only paragraph which he had seen outside the electrical journals being the unobjectionable notice in the *Times*. He explained that he seldom saw other daily morning papers than the *Times*, and that he was absent from England during most of the latter half of July. Prof. Thompson also assured us that he had been asked in the spring of the present year to make a professional report on the cells, and that he declined, for reasons apart from the goodness or badness of the cells, to do so, although a handsome fee was offered him. He added that he went to the exhibition of the miners' lamp at Mr. Walsh's office equally without fee, and after consultation with Mr. Ellis Lever, whose name in connection with the safety lamp competition is so well known. His remarks on that occasion about electric safety lamps had been only reported so far as it suited the purpose of the promoters of the Eclipse Battery Company. He did not think that what he said about the miners' lamp in particular had been exaggerated, but the report was not *verbatim*. We do not think it necessary to further discuss the matter of the "Eclipse" primary battery, but we shall keep the name of Walsh indelibly impressed upon our memory in case it should crop up again in some future electrical speculation. With respect to Prof. Thompson and other public men, whose time is too much occupied to enable them to closely watch daily events, we would suggest that a yearly subscription to Romeike's press agency would prove advantageous, as anything reported in the newspapers connected with their sayings or doings would be forwarded to them immediately upon publication.

MR. HOLROYD SMITH regrets that we published his letter with the report on the Blackpool Tramway. It was not addressed to the "The Editors" but to the firm. Now, as we have journalistic matters sent indiscriminately to "The Editors," the firm, and to our individual selves, we can only conclude that any communication bearing upon such subjects, unless marked *private*, which was not the case with the letter in question, are sent for publication.

MR. ELIESON has found a champion in Mr. Radcliffe Ward, and it is very cheering to the philanthropic mind to see the inventor of a rival scheme helping on another, and sacrificing self for the welfare of the community at large. Mr. Elieson thoroughly deserves all the encomiums which can be showered upon him, but what is now wanted is that all interested in electric traction should vie one with another in outstripping steam, cable, compressed air, and other systems of propulsion. This, however, it is to be feared, can only be satisfactorily accomplished when fewer restrictions are thrown in the paths of the pioneers of this new industry. As several gentlemen who were already associated with tramway work are supporting Mr. Elieson in his operations, it may be that his road to success will be made somewhat more smooth than that of some of his competitors.

ELECTRO-CHEMICAL COLORATION OF METALS.

By ALEXANDER WATT.

IT is well-known that when solutions of certain salts, as acetate of lead, for example, are electrolysed, peroxide of the metal becomes deposited upon the anode in the form of a thin, adherent film representing all the colours of the spectrum. These effects, known as "Nobili's rings," have been produced with a variety of salts and upon various metals—polished steel being generally recognised as yielding the most brilliant results. Since this metal, however, owing to its extreme hardness and general unsuitability, cannot be so readily formed into articles of an ornamental character as copper, brass, or German silver, it occurred to the author some years ago that if these beautiful colorations, or "metallo-chromes," as they are termed, could be produced upon nickel-plated surfaces, that the extreme whiteness and brilliancy of this metal would, of all others, be the most effective for displaying the iridescent tints referred to. To determine the fact, several plates of brass about 3 inches square were first highly polished and then well coated with nickel; the plates were afterwards "finished" by an expert workman, who secured for them the finest polish attainable. A nearly saturated solution of acetate of lead was now prepared and carefully filtered. The solution was then poured into a shallow dish which was next covered with a plate of glass to exclude dust. Three small copper-zinc cells, arranged in series, were employed to furnish the current, and all being thus ready, a nickel-plated plate was laid horizontally in the acetate bath, and put in contact with the positive pole of the battery. The negative wire was then immersed and allowed to approach as near as possible to the nickeled plate without touching, when the coloured ring commenced to form immediately, and in a few seconds reached the maximum of coloration. As anticipated, the brilliant colours contrasted strongly with the polished nickel and produced a fine effect, especially when a piece of white paper was reflected upon the surface.

In making further experiments with varying strength of current, it was found that when too strong a current was employed a brown colour only was produced.

To render "metallo-chromy" practically applicable to nickel-plated articles of ornament, there are several points that must not be neglected. The coating of nickel must be something more than a mere film, otherwise a voltaic couple will be set up between the nickel and the underlying metal when immersed in the acetate of lead solution, and the nickel will strip or peel off; a fair coating of nickel is absolutely necessary. The metal of which the article is made (say brass, for example) should be free from small cavities or hollows, otherwise these imperfections will mar the beauty of the coloured film. In the early experiments of Nobili, Becquerel, Gassiot, and others, various methods were adopted to give form or design to the metallo-chromes, but probably a few other suggestions may not be unacceptable. In producing the colorations upon nickel-plated surfaces, the author adopted the following method:—Thin copper wire was worked up into patterns of various design, as a cross, star, anchor, &c., and in the centre of each pattern a vertical wire about 6 inches long was attached by means of silver solder and the blowpipe: thus, to form a cross, for example, two short pieces of thin copper wire were taken, one piece being about $\frac{3}{4}$ inch long, and the other $\frac{1}{2}$ an inch, these being arranged crosswise were soldered together. To the centre of this a vertical wire was attached in the same way, to serve as the conducting wire for connection with the battery. To produce the coloured film in this design, the conducting wire of the cross was first connected to the negative pole of the battery; a nickel-plated plate was then immersed in the acetate bath and put in contact with the positive pole as before; the wire cross was then steadily lowered into the bath and allowed to nearly touch the plate, when the coloured design at once began to form. To hold the pattern exactly in its right position—that is horizontally—was at first somewhat difficult, but a little practice soon overcame the difficulty; if not held in such a position that all parts of the cross would be at an equal distance from the plate, the coloured impression would be wider in some parts than others, and thus spoil the effect. To overcome this it was found necessary, when immersing the wire pattern, to let it touch the anode for an instant, and then withdraw it to about $\frac{1}{32}$nd of an inch from the plate, when the coloured film immediately commenced. In producing the metallo-chromes, care must be taken not to allow particles of the spongy coating of lead which deposits upon the cathode to fall upon the plate, otherwise they will cause a series of white spots by preventing the formation of the peroxide upon the surface beneath them. It is also necessary to be strictly careful in keeping dust out of the bath, since the slightest particles resting upon the surface to be coloured will give the design a spotted appearance which entirely destroys the beauty of the film. After a series of designs have been produced in the acetate of lead bath, it becomes charged with free acid, and when in this condition the coloured film will become partially or wholly redissolved if the plate be allowed to remain too long in the bath after the design has formed. It is better to remove the coloured article from the bath as quickly as possible and plunge it into cold water. If, however, it is desired to produce several different designs upon one piece of nickel-plated work, a fresh neutral solution should be used. When the bath has become too acid to work with safety, it should be transferred to a bottle, a little oxide or carbonate of lead added, and repeatedly shaken. After an hour or so the solution may be filtered and used again. If several solutions are kept for daily use, as soon as one bath becomes too acid for working it should be put aside to recuperate in the manner suggested, and a fresh or restored bath poured into the dish for further operations; this vessel, however, should be rinsed and wiped dry each time before pouring in the filtered solution. Another precaution which must not be neglected is to remove the deposited lead from the cathode each time before applying it again, which may be readily done by dipping the pattern in a vessel of cold water, and brushing the lead off with a soft brush.

Colouring or Staining Brass.—In finishing ornamental brass work, different processes are adopted to produce varied effects of colour; thus "dipping acids," variously composed, are used to produce certain shades of yellow, from pale lemon to a rich orange, while other substances are employed to impart a more or less black stain upon certain classes of brass work for optical instruments and other purposes. To produce a black stain upon brass, a solution of chloride of platinum is generally employed, but since this is an expensive salt, its employment is necessarily limited in its application. To obtain a black colour which would be applicable to large pieces of brasswork, and at the same time less costly than the platinum salt, the author made a series of experiments. Well knowing that brass was far more difficult to "stain" than copper, the following method was adopted, which not only produced an intense black stain, but also varying shades of brown, from chocolate colour to a deep sepia tint. After trying many different substances, in solutions of varying degrees of concentration, the process given below was finally hit upon, and the results obtained were in the highest degree satisfactory, both from an artistic and economical point of view. Bearing in mind that the black deposit—improperly called a "stain"—produced upon brass by means of chloride of platinum is very easily rubbed off, the author resolved if possible to obtain a firm, adherent film which would resist ordinary rough usage. Since these results could not be obtained upon brass, it was determined to give this alloy a slight coating of copper in a sulphate of copper bath in the first instance. The brass article, after

being dipped in a mixture composed of nitric and sulphuric acids and water (ordinary dipping acid) was well rinsed, and then immersed in a sulphate of copper bath composed of 1 lb. of sulphate of copper, 1 lb. of sulphuric acid, and one gallon of water. In from five to ten minutes, with the current from a single Daniell cell, the deposit of copper was sufficiently thick for the purpose intended, when the article was removed from the bath and well rinsed in hot water. A solution of sulphide of barium (about 5 grains to an ounce of water) was then poured into a vessel, and the coppered article, being held by its suspended wire, at once immersed. On coming in contact with the sulphide a light brown tone was immediately produced, which gradually deepened until, after a few moments' immersion, the surface assumed an intense but brilliant black. On removing the article at this stage it was first plunged into hot water, then into boiling water, and afterwards set aside until dry, which occupied but a few moments. The black film thus obtained was very firmly adherent, and when rubbed with a chamois leather it soon acquired a brilliant polish. Other articles of various forms were subsequently treated in the same way, and when it was desired to obtain a chocolate brown colour the piece was only allowed to remain in the sulphide solution about half a minute, or even less, when a most pleasing brown tone was obtained, possessing quite a metallic lustre. Sulphides of ammonium or potassium may also be used, if desired. It now became evident that very varied effects could be produced in this way; for example, parts of an ornamental specimen of brass work could be stained brown; other surfaces black; portions could be left in the natural colour of the brass, and other surfaces could exhibit the rich pink-red hue of electrolytic copper. The idea was soon carried into effect in the following way:—The surfaces which were to remain yellow (whether matted or burnished) were coated with a film of paraffin, applied by gentle heat, the piece of work was then placed in the copper bath and moderately coated with copper, after which it was well rinsed, finally, in lukewarm water; it was then wiped dry with a piece of clean soft diaper. To produce the brown and black colorations upon various parts of the work, two pastes were made with jewellers' rouge and water, to which was added more or less sulphide of barium, according to the tone of colour required; these pastes were laid on the parts to be coloured with a brush, the operation being done as quickly as possible, so as to obtain uniform results. When all these surfaces had been treated in this way, the article was held under a tap, the water turned on, and a soft, long-haired brush freely used to remove all traces of the rouge mixture. The object in using a stream of water for this purpose was to prevent the sulphide of the rouge paste from staining the copper surfaces, which were to be retained in their natural colour. It was found, however, that a slight discoloration appeared on portions of the copper surfaces, arising from the cause referred to, but these were afterwards removed, as also traces of oxidation, by dipping the article for a moment in a moderately strong solution of cyanide of potassium, and then rinsing it thoroughly in boiling water, which also had the effect of removing the paraffin from the brass surfaces. The piece of work was then again rinsed in boiling water, and lightly brushed to remove further traces of paraffin; after this it was wiped dry; the brass surfaces to be left bright were then burnished, the black, or bronze-coloured parts were polished with a chamois leather where necessary, and the article finally coated with a thin film of colourless varnish.

It will be readily seen, from the details given, that brass work treated in the way described—that is, after receiving a preliminary, or partial coating of copper, electrolytically—may be ornamented to a very high degree; indeed, the process would be specially applicable to chandelier work, finger-plates of doors and ornamental cast-brass work of any kind.

PRACTICAL ELECTRICAL MEASUREMENT.

By J. SWINBURNE.

(*Continued from page* 165.)

DYNAMOS AND MOTORS.

Dynamos and motors have to be tested as to their output, electrical and gross efficiency, and compounding, or constancy of electromotive force.

Motors and dynamos will be treated together, as a motor is simply a dynamo with some of its conditions reversed, and follows the same laws and principles of design. There are still, no doubt, a few makers who hold to the old fallacy that a dynamo should have a strong field and few ampère turns on the armature, while a motor should have a weak field and many ampère turns on the armature. This idea is based on the theory that in a dynamo the armature current weakens the field or lessens the induction through the armature, while in a motor it increases it. This reasoning is fallacious, as the armature current in a motor also lessens the induction in the armature unless the brushes are given a lead in the wrong direction. If the brushes are given a lead in the wrong direction, the induction is increased in a dynamo and in a motor, but the machine sparks and wears out the commutator and brushes.

Of course, if a light motor is wanted, it is not designed like a heavy but efficient dynamo, but the design of the light dynamo does not differ from that of a light motor in any respect. The interchangability of dynamos and motors was first formally published by Mr. Mordey, but even now these points cannot be too fully discussed, as many engineers still adhere to the old theories, and when they have to superintend an installation for electric transmission of power, they put down motors made on the principle that the worst possible dynamo is the best motor.

Dynamos are generally made of one of four classes, 50 volts, 100 volts, arc lighter, or electro-deposition machines.

For testing work it is best to run the machine off into resistances. Secondary batteries might be used, to save power, but as only shunt machines could be run off into them, they would not pay. A motor can also be used to absorb the power and give a percentage back to the countershaft; but the cost of the motor and the troubles and complications make that also out of the question.

The test room of a dynamo works, or of any establishment where machines are tested, must be provided with resistance frames which will take the largest currents wanted. The resistances may be made capable of carrying, say, 1,000 ampères. This with 100 volts requires an engine indicating from 170 to 200 H.P., which is greater than is generally available. The resistances are generally made up so that a larger or smaller number of spirals of wire can be put in parallel. Each spiral must therefore be able to take 100, or perhaps 150 volts on it without heating excessively.

The mho switches described for regulating large currents in the calibration of ammeters and illustrated on page 105, are very suitable. For currents of from 1 to 1,000 ampères, only three switches are required. The first gives ·01 to ·1 mho, that is, from 100 to 10 ohms, so that if the machine gives 100 volts or so, this switch regulates the current in ampère by ampère. The next switch is from ·1 to 1 mho, thus regulating the current by tens of ampères. The third is from 1 to 10 mhos, thus regulating the current by a hundred ampères at a time. The first resistance is half an ohm; as this is in when the switch is at 1 mho, it has to be capable of taking 100 ampères. The next resistance is $\frac{1}{8}$th ohm, which is in circuit when the switch is at 2 mhos. This must be able to carry 200 ampères, and so on. The denominator of the fractions representing the resistances in a mho switch, run in progression 1×2, 2×3, 3×4, and so on up to 9×10, or $\frac{1}{90}$th of an ohm. The resistance which is left last, and is never

taken out is, of course, $\frac{1}{10}$th, or 10 mhos. These resistances must be able to carry currents of 100, 200, 300 ampères, and so on. If there is not power to run off machines giving 100 volts and 1,000 ampères, the last spirals may be made smaller. For instance, if 100 volts and 250 ampères, or 50 volts and 500 ampères are the maximum loads, the spirals after 3 mhos may be made to carry 150, 200, 250 ampères, and so on, as there will never be 100 volts on them. It is best, however, to make the coils large enough to take large currents, as they will then be available for machines giving outputs at electromotive forces up to, say, 200 volts.

The resistances should not be made of iron spirals or gauze, as iron is circularly magnetised, and the self-induction soon destroys switches. If spirals are used they should be alternately right and left handed, so as not to affect instruments. Probably it would pay best in the long run to use carefully measured platinoid wire resistances throughout, as that admits of measurement of large currents by means of a voltmeter put across the resistance terminals. If this is not always used, it is always some check on the ammeters.

For arc light machines a separate set of resistances taking 15 to 20 ampères is required. These need not have mho switches, but may be merely arranged in series. One switch cuts out resistance ohm by ohm, and another 10 ohms at a time. A third goes by steps of 100 ohms at a time up to the highest resistance required, 300 being probably the outside. This set of resistances should be very well insulated.

For electro-deposition machines giving from 5 volts upwards a fourth, and perhaps a fifth, switch may be added to the 100-volt set. These are from 10 to 100, and from 100 to 1,000 mhos. The great trouble with these low volt machines arises in the leads and instruments. It is exceedingly difficult to work with a large current and 5 or 6 volts, as the whole of the electromotive force is apt to be lost in the leads, switches and instrument connections. The resistances for these large currents may be made of spirals of wire. Strips of lead immersed in a tank of water are very useful for this sort of work, and work well even up to 50 volts. The writer has not tried them with 100 volts, but there seems little reason to suppose they will not work. The rate at which lead strips will get rid of power in water is very surprising ; and these resistances are very cheap to make. Of course other metals will not do, as one end acts as an anode and the other as a cathode.

Mercury cups may be used for connections in large current work, but they are untidy, and the mercury is often spilled and lost and is expensive. An amalgam of mercury and copper is very handy. It is soft and pasty, but sets hard, becoming soft and pasty again when hammered or rubbed in a mortar. It can be made by electro-depositing copper into mercury.

The resistance arrangements just described may not be sufficient for all purposes, as it is often necessary to separately excite a machine. If the machine is wound with a fine shunt wire the arc resistances may be used. It is then as well to have them adjustable by tenths of an ohm, so that there are four switches. For separately exciting machines of new types wound with large wire for experiment, the large resistances may be used, but that does not admit of taking full load readings. A spare set of resistances is therefore a great advantage.

The first thing to test is the resistance of the shunt circuit, main circuit and armature. The methods of taking very low resistances have already been described.

The machine should also be tested for insulation, care being taken to see that there is no leak to the frame from any part of the circuit, or from the shunt and the main wires. Insulation tests should be taken, as already pointed out, with the full electromotive force of the machine.

Before taking readings the machine should be run for an hour or several hours if it is large, so that it may get as hot as it will in practice. As the magnets are wound with copper wire their resistance varies considerably with the temperature. When the machine has been running at full load for some time readings should be taken in two sets. One with the load gradually increasing and one with it decreasing. A machine for incandescent work should be made to compound up to allow for the loss in the leads and for the slower speed of the engine at full load. It may then be tested either at constant electromotive force or at constant speed, or between the two. In practical work it is between the two, but it is generally best to test it at constant electromotive force. If the machine is shunt wound it should be run on open circuit for some time, to see that the shunt does not get too hot. The electromotive force of a slow-speed or badly-designed machine often rises considerably at no load.

A shunt machine wound for charging accumulators with constant current at approximately constant speed cannot be tested as a self-exciting machine without accumulators, as it is unstable ; it must, therefore, be separately excited, and its performance can be deduced from the results so obtained.

Immediately after the full load tests the machine should be shut down and the resistances of the different circuits taken hot. These measurements give data for finding the temperature of the armature and field magnets. The hand should not be relied on as a guide, as a bare armature wire at 40° C. will feel hotter to the touch than a cotton-covered unvarnished wire at 50° or 60° C.

Arc light machines, of course, give no special trouble. As far as the machine itself is concerned the curve may be taken accurately between points 15 per cent. on each side of the normal current, and enough data will be obtained.

In many cases there may not be sufficient power available to drive the machine at full load. The machine may then be run slow so as to give a low electromotive force, the shunt being separately and fully excited. This gives the full torque, and so the armature is subjected to its full driving strain ; and the lead of the brushes is also the same as at the higher speed. The compounding test taken at a slow speed is, of course, inaccurate, but the exact performance at a high speed can be got by correction from it. If the machine has large armature bars it should also be run at full speed with no load to see if the bars heat from Foucault currents. This also gives opportunity of seeing how the armature runs as to balance. The method of balancing an armature on knife edges usually employed by dynamo makers does not really ensure balance, as one end may be out of balance on one side and the other on the other, which would not show on the knife edges, but would give trouble in the dynamo.

Many points connected with testing dynamos are here left untouched, because their discussion would lead us into questions of dynamo design and manufacture, which are beyond the scope of these papers.

(To be continued.)

SELF-INDUCTION AND ITS MEASUREMENT.

By E. C. RIMINGTON.

(*Continued from page* 161.)

To find the energy taken from the battery in the form of consumption of zinc, &c., when a current is started in a circuit.

The energy taken from the battery equals E Q.

Now Q has been shown to equal $\frac{E}{R}\left(t - \frac{L}{R}\right)$, if t be sufficiently long.

Therefore $$E\,Q = \frac{E^2}{R}\left(t - \frac{L}{R}\right)$$

Now the work done in the circuit equals

$$\frac{E^2}{R}\left(t - \frac{3}{2}\frac{L}{R}\right)$$

Hence the excess of the energy taken from the battery

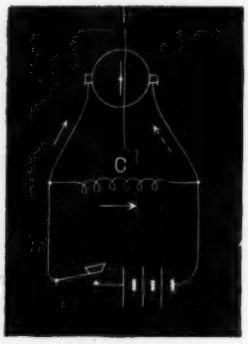
over that employed in doing work in the circuit equals

$$\frac{E^2}{R}\left(\frac{3}{2}\frac{L}{R} - \frac{L}{R}\right) = \frac{E^2}{R} \cdot \frac{L}{2R}$$

The work represented by this goes to increase the potential energy of the circuit by creating a magnetic-field in the space surrounding it, and is given out again in the form of work in the circuit when the current is stopped.

The presence of an extra current in the same direction as the permanent current when the latter ceases is experimentally shown in the well-known experiment due to Faraday.

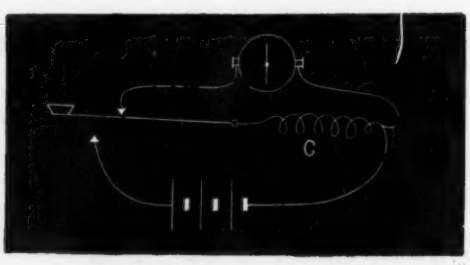
A coil, C, possessing self-induction is connected up with a battery and galvanometer as shown in the diagram. When the key is closed the current from the



battery will divide between C and the galvanometer as indicated by the arrows, producing a permanent deflection on the galvanometer, say to the right. The galvanometer needle is brought back to zero, and a stop is put against it, preventing it from deflecting. On liberating the key the extra current in C will be in the direction of the arrow and will flow through the galvanometer in the direction of the dotted arrow, producing a momentary deflection to the left.

A further experiment of Faraday's shows the effect due to self-induction when the battery circuit is closed. The connections are the same as the above. When the key is depressed and the deflection to the right has become steady a stop is put touching the needle and preventing its motion towards zero when the key is raised. The key is now raised and again depressed when a momentary deflection still further to the right is obtained. This is due to the E.M.F. of self-induction sending a current through the galvanometer in the direction of the full arrow in addition to the current from the battery, since the latter alone could cause no increase in the deflection, as the needle is already at its position of maximum deflection.

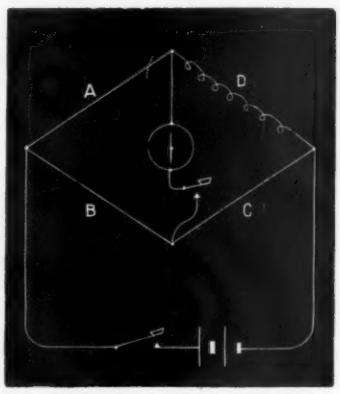
The extra current due to the cessation of the permanent current may also be shown with the connections, as in the second figure. When the key is down



a permanent current flows through C; when the key is liberated, the battery is cut off, and C is circuited through the galvanometer, on which a throw will be obtained, provided the play of the key be not too large. By varying the latter the throw will be varied.

Another well-known instance is the case of the Wheatstone bridge, where one or more of the arms possesses self induction; suppose it is the arm, D.

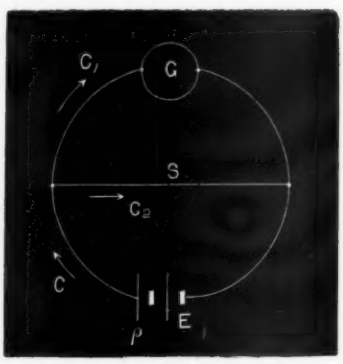
A balance is obtained by pressing the battery key before that of the galvanometer. If now the galvanometer key be put down, and after it the battery key,



a throw in one direction will be shown on the galvanometer. On releasing the battery key an equal throw in the opposite direction will be obtained. These throws are both caused by the existence of a momentary E.M.F. due to self-induction in the arm, D.

Let us now consider the case of a galvanometer and shunt in circuit with a battery, where the coefficient of self-induction of the shunt is zero, and as a necessary consequence the mutual induction between the galvanometer and shunt also zero.

Let L be the co-efficient of self-induction of the galvanometer, G its resistance, S that of the shunt, and ρ that of the battery branch.



Let the currents in ρ, G, and S be C, C_1, and C_2, respectively, at some moment, t, reckoned from closing the battery circuit.

Then
$$C = C_1 + C_2 \qquad (1)$$

$$E = C\rho + C_2 S \qquad (2)$$

$$C_2 S - C_1 G - L\frac{dc_1}{dt} = 0 \qquad (3)$$

from (3) $$C_2 S\,dt - C_1 G\,dt = L\,dc_1 \qquad (4)$$

from (1) and (2)
$$E = C_1\rho + C_2(\rho + S)$$

or
$$C_2 = \frac{E - C_1\rho}{\rho + S}.$$

Substituting this in (4) we have

$$\left(\frac{E - C_1\rho}{\rho + S} \cdot S - C_1 G\right) dt = L\,dc_1$$

$$\{ES - C_1(\rho G + \rho S + GS)\}\,dt = (\rho + S)L\,dc_1$$

$$\frac{dc_1}{ES - pc_1} = \frac{dt}{(\rho + S)L}$$

where p stands for $\rho G + \rho S + G S$.

Then
$$\int_o^{c_1} \frac{d c_1}{E S - p c_1} = \frac{1}{(\rho + S) L} \int_o^t d t$$
$$-\frac{1}{p} \int_o^{c_1} \frac{d (E S - p c_1)}{E S - p c_1} = \frac{t}{(\rho + S) L}$$
$$\log_e \frac{E S - p c_1}{E S} = -\frac{p t}{(\rho + S) L}$$
$$E S - p c_1 = E S \cdot e^{-\frac{p t}{(\rho + S) L}}$$

Therefore
$$C_1 = \frac{E S}{p} \left\{ 1 - e^{-\frac{p t}{(\rho + S) L}} \right\}$$

or the current through the galvanometer at any instant, t secs., after closing the battery branch, equals
$$\frac{E S}{\rho G + \rho S + G S} \left\{ 1 - e^{-\frac{(\rho G + \rho S + G S) t}{(\rho + S) L}} \right\}$$

If t be sufficiently long for the current to attain its permanent value
$$C_1 = \frac{E S}{\rho G + \rho S + G S}$$
the value given by Ohm's law.

Current through the shunt—
$$C_2 = \frac{E - C_1 \rho}{\rho + S} = \frac{E - \frac{E \rho S}{p} \left(1 - e^{-\frac{p t}{(\rho + S) L}} \right)}{\rho + S}$$

For shortness write
$$m = -\frac{p t}{(\rho + S) L}$$
$$C_2 = \frac{E}{p (\rho + S)} (p - \rho S + \rho S \cdot e^m)$$
$$= \frac{E}{p (\rho + S)} (\rho G + G S + \rho S e^m)$$
$$= \frac{E G}{p} \left\{ 1 + \frac{\rho S}{(\rho + S) G} \cdot e^m \right\},$$

or current through shunt equals
$$\frac{E G}{\rho G + \rho S + G S} \left\{ 1 + \frac{\rho S}{(\rho + S) G} e^{-\frac{(\rho G + \rho S + G S) t}{(\rho + S) L}} \right\}$$

If t be sufficiently long
$$C_2 = \frac{E G}{\rho G + \rho S + G S}.$$

To find the total current
$$C = C_1 + C_2 = \frac{E S}{p} (1 - e^m) + \frac{E G}{p} \left(1 + \frac{\rho S}{(\rho + S) G} \cdot e^m \right)$$
$$= \frac{E}{p} \left\{ G + S - e^m \left(S - \frac{\rho S}{\rho + S} \right) \right\}$$
$$= \frac{E}{p} \left(G + S - \frac{S^2}{\rho + S} e^m \right)$$
$$= \frac{E (G + S)}{\rho G + \rho S + G S} \left\{ 1 - \frac{S^2}{(\rho + S)(G + S)} e^{-\frac{(\rho G + \rho S + G S) t}{(\rho + S) L}} \right\}$$

If t be sufficiently long
$$C = \frac{E (G + S)}{\rho G + \rho S + G S} = \frac{E}{\rho + \frac{G S}{G + S}}$$

(To be continued.)

ON THE THEORY OF THE DYNAMO.

By O. FRÖLICH.

SINCE the publication of my treatise "The Dynamo-electric Machine," there have appeared in this journal (*Elektrotechnische Zeitschrift*) and in others, both German and foreign, a series of critical essays. The examination which my representation undergoes in these is mainly unfavourable, and the only result which I can claim seems to consist in the fact that my representation is mentioned wherever the theory of the dynamo comes under discussion, and has, at any rate, acquired some adherents.

The objections raised against my representation are, for the most part, not justified, and some of them are even trifling. I find myself therefore compelled to again have recourse to the columns of this journal for my own defence. Those objections which I readily admit as justifiable, coincide for the most part with my own remarks on the meaning and the limits of my representation.

The inducement for my defence is the greater as there has just appeared a French version of my book from the careful pen of E. Boistel which will possibly increase the scope for discussion.

I shall in the following lines examine in the first place the works of my critics, supplying everywhere computations of the experiments concerned which agree better with my representation. To these replies is then appended the discussion of various interesting points, *e.g.*, the increase of the resistance of the ring with the speed, the equality of the electrical and mechanical work, the constancy of the constants in my representation, the dependence of the constants upon the position of the commutator and on the measure of the magnetism.

One point may be traced through most of these considerations, a point which was, indeed, mentioned in my former writings but which was practically disregarded, that is, the increase of the resistance of the ring with the velocity. It appears that the recognition of this circumstance is partly adapted for supplying deficiencies in our knowledge, whilst in part it explains seeming deviations from my representation.

The new experiments communicated are the property of the firm Siemens and Halske.

O. E. MEYER AND AUERBACH. THE GRAMME MACHINE.

In the *Elektrotechnische Zeitschrift* (1886, p. 240) Meyer and Auerbach have taken exception to my interpretation of their experiments with the Gramme machine. They seek to show that the differences between the actual experiments and my representation are considerable, and further, that the theory of Clausius adapts itself much better to these experiments.

The calculation according to the formula of Clausius can be cheerfully accepted as it forms the first application of this theory. It must be remarked that the weightiest objection which the authors bring against my representation applies also to the theory of Clausius.

The authors show in Table I., p. 241, that for equal values of v/W the accompanying values of the current, J, in their experiments are considerably different, and that therefore J cannot depend solely on v/W, as would be the case according to my curve. They do not seem to have noticed that, according to the formula of Clausius (p. 244), J depends only on v/W, though in a more complicated manner than according to my representation. If, therefore, the observations really show that J does not depend solely upon v/W, the formula of Clausius would be found insufficient.

If, according to Table I., the values of J for the same value of v/W vary from $\pm$ 4·5 per cent. to $\pm$ 6·2 per cent., these variations apply also to the theory of Clausius, which gives an accurate representation only of the mean course; a good agreement, therefore, does not exist. Lastly, it would have to be shown that the values of the constants found by Meyer and Auerbach correspond to their physical signification.

But the reason of the seeming deviations lies elsewhere. The Gramme machine of Meyer and Auerbach dates back to the first period of the construction of dynamos, and contains therefore very probably relatively much wire on the ring and little iron in the limbs of the magnet. Hence it is likely that not only the reaction of the ring-currents upon the magnetism, but especially the change of the resistance of the ring according to the speed is considerable. This latter change could not be taken into account in these measurements, as it was then unknown. But in the more recent memoir by Meyer and Auerbach it is also not mentioned.

This is proved by the curves in which Meyer and Auerbach (fig. 1) represent J as a function of $\frac{v}{W}$ in one case when W is constant, and in another when v is constant. If we put a for the resistance of the ring $a_0 \cdot (1 + \gamma \cdot v)$, then according to my representation

$$J = \frac{f \cdot v}{a_0 \cdot (1 + \gamma \cdot v) + s + u} - J_1$$

or if we develop γ and put $W_0 = a + s + u$:

$$J = \frac{f \cdot v}{W_0} - \gamma \cdot a_0 \cdot f \frac{v^2}{W^2_0} - J_1$$

If we therefore disregard the change of the resistance of the ring, the curve of the current no longer shows a right line, but a curve concave to the axis of the abscissæ, like the curves drawn by Meyer and Auerbach. But if we always calculate the real total resistance $W = a_0 \cdot (1 + \gamma v) + s + u$ and put J as a function of $\frac{v}{W}$ a right line is obtained as in my representation.

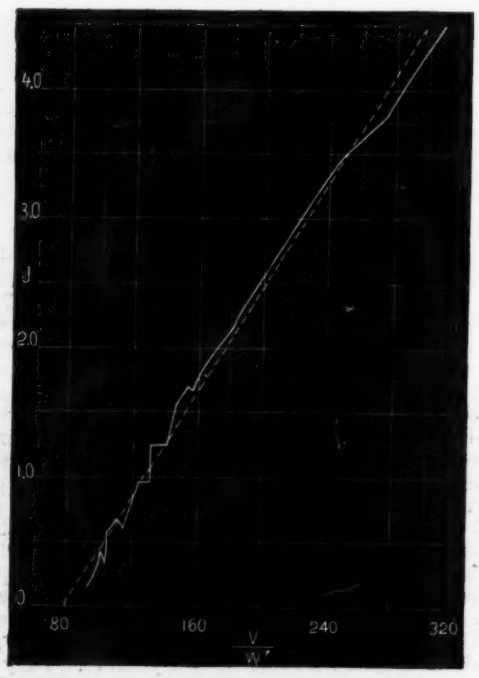


FIG. 1.

We may now calculate γ from these curves, fig. 1; we obtain as a mean $\gamma = 0{\cdot}0023$, whence at a speed of 430 turns the resistance of the ring would be doubled. This is by no means improbable; I have in a machine by Siemens and Halske belonging to that epoch of construction obtained a decidedly larger coefficient.

Among the original observations of Meyer and Auerbach I have omitted those in which the current was smaller than 0·2 (in the arbitrary unit adopted in their memoir), since smaller currents evidently belong to the sphere of remanance; in all others the increase of the resistance of the ring was taken into account (on the above assumption for γ) and an amended curve was traced.

Unfortunately there is no statement as to the resistances of the limbs and the ring when at rest.

It is merely said in the original memoir that the resistance of the machine was 1·02 Siemens units, and that the resistance of the limbs was "a small value." The latter cannot possibly be correct. In default of a decisive statement I have assumed that as in many machines of that date the ring when at rest and the limbs have the same resistance, and I have put $a_0 = 0{\cdot}50$.

Table I. and fig. 1 show the result.

In the table v denotes the speed, W_0 the total resistance according to Meyer and Auerbach, W the total resistance corrected by the increase of the resistance of the ring, J_1 the current as observed and J_2 as calculated, ΔJ the difference of both values.

TABLE I.

v	W_0	W	$\frac{v}{W}$	J_1	J_2	ΔJ
187	1·78	2·00	93·5	0·19	0·31	+ 0·12
211	1·78	2·03	104	0·34	0·52	+ 0·18
236	1·78	2·06	115	0·58	0·74	+ 0·16
275	1·78	2·10	131	0·97	1·07	+ 0·10
302	1·78	2·13	142	1·24	1·29	+ 0·05
342	1·78	2·18	157	1·66	1·59	− 0·07
435	1·78	2·33	187	2·30	2·20	− 0·10
557	1·78	2·44	228	3·15	3·03	− 0·12
642	1·78	2·52	255	3·56	3·57	+ 0·01
719	1·78	2·61	276	3·82	4·00	+ 0·18
759	1·78	2·64	287	4·07	4·22	+ 0·15
794	1·78	2·69	295	4·20	4·38	+ 0·18
876	1·78	2·83	310	4·50	4·68	+ 0·18
824	7·08	8·03	103	0·45	0·50	+ 0·05
824	5·30	6·25	132	1·24	1·09	− 0·15
824	4·38	5·33	155	1·68	1·55	− 0·13
824	3·97	4·92	167	1·90	1·79	− 0·11
824	3·64	4·59	180	2·13	2·06	− 0·07
422	3·89	4·38	96	0·23	0·36	+ 0·13
422	3·51	4·00	105	0·58	0·54	− 0·04
422	3·31	3·80	111	0·67	0·66	− 0·01
422	2·92	3·41	124	0·97	0·92	− 0·05
422	2·34	2·83	149	1·59	1·43	− 0·16
422	2·10	2·59	163	1·85	1·71	− 0·14
422	1·73	2·22	190	2·35	2·26	− 0·09

The curve obtained displays but a slight bend; its mean deflection from a right line is 5·9 per cent.; the values for the right line are $f = 0{\cdot}0202$, $J_1 = 1{\cdot}58$.

The current curve is already decidedly more regular than the one which I formerly traced in which the resistance of the ring was assumed to be constant. Hence it is probable that if the increase of the resistance of the ring were measured with the speed the result would agree well with my representation.

Lastly I must call to mind that the errors of observation in these experiments are very considerable. The experiments have extended over more than two months; each number given is the mean of a series of experiments which were performed at quite different times, and which vary from each other up to 50 per cent. Under such circumstances they cannot lay claim to a high power of demonstration.

I consider that I have already shown from the observations themselves that a correspondence between these experiments and my representation, if more accurately calculated, is probable, and that they cannot certainly serve as arguments against my representation.

J. AND E. HOPKINSON, EDISON-HOPKINSON AND EDISON MACHINES.

Messrs. Hopkinson have determined the characteristic without a current in the ring in an Edison-Hopkinson machine, and they have found that it agrees badly with the formula which I made use of. If all the

observations are made use of for determining the constants, we obtain a curve decidedly flatter in its middle portion and steeper in its latter part than the curve observed.

I admit these deviations, and remark that I know of no characteristic without a current in the ring with "so abrupt a knee" and with so great a deviation from my formula.

This circumstance, however, does not admit of any decision whether my representation suits for this machine or not. To this end the characteristic with a current in the ring is requisite, but is not given in their researches.

I have never, moreover, raised the claim for my representation that the curve of the magnetism observed is always accurately represented in its whole extent by my formula. An agreement within the extent of practice only has been pre-supposed. If an agreement exists for the entire extent of the curve, each coefficient has the physical signification ascribed to it. If such agreement prevails only within the sphere of practice the physical signification is only approximate. In both cases, however, the formula is sufficient for representing the observations with a sufficient accuracy, and for solving all practical questions.

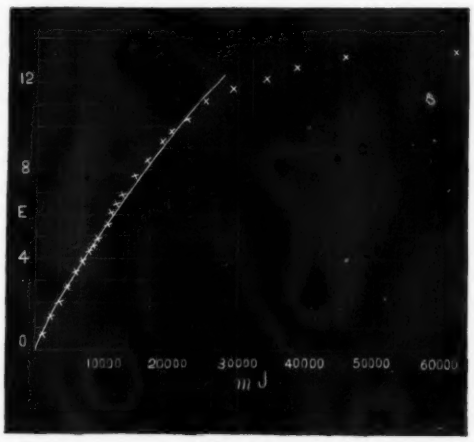


FIG. 2.

The curve given by the Messrs. Hopkinson furnishes, also, a result sufficient for practical purposes. If we only take into consideration the observations as far as $m\,\mathrm{J} = 26{,}000$, which about corresponds with the practical region, then, in the formula

$$\mathrm{M} = \frac{m \,.\, \mathrm{J}}{a + b \,.\, m \,.\, \mathrm{J}}$$

$a = 1{\cdot}674$, $b = 0{\cdot}02086$; and the curve traced by their means (see fig. 2) represents satisfactorily the observations, as far as that limit.

The machine used by Hopkinson is an Edison dynamo modified, especially in the construction of the limbs of the magnet. I shall show in the sequel that the Edison machines built in Germany agree with my formula in their electrical behaviour. The German Edison Company, possessors of the machine, have kindly permitted the use of the subjoined experiments; the experiments themselves were made by Siemens and Halske.

The machine had the model mark, P 300, and was to yield about 100 volts and 240 ampères.

The resistances amounted to:—Ring (a) 0·01785 ohm (cold), 0·02204 ohm (warm); limbs (n) 25·30 ohms (cold), 26·89 ohms (warm). The increase of the resistance with the number of rotations had not been measured, and cannot, therefore, be considered in the calculation.

In the first place the machine was closed in itself without external resistance, and the polar difference of potential $\mathrm{P}\,\infty$ observed at various speeds. There were found:—

ν	$\mathrm{P}\,\infty$	ν	$\mathrm{P}\,\infty$	ν	$\mathrm{P}\,\infty$
	Volt.		Volt.		Volt.
806	109	803	109	544	48
733	95·0	743	96	646	73·2
643	76·1	640	79	724	94
541	50·5	537	53	808	109
418	22·5	418	22·5		

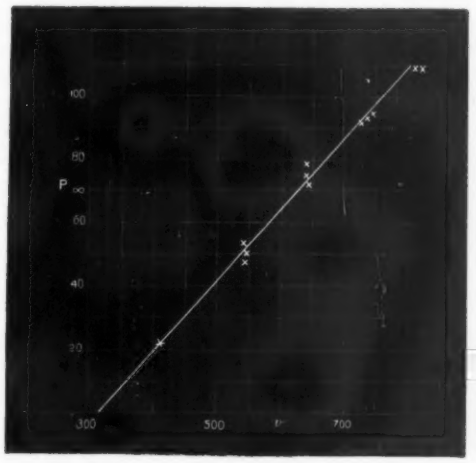


FIG. 3.

If these observations are plotted out graphically (see fig. 3), and if a mean right line is drawn, we find, according to the formula $\mathrm{P}\,\infty = f\,\nu - \mathrm{P}_i$, the values:—

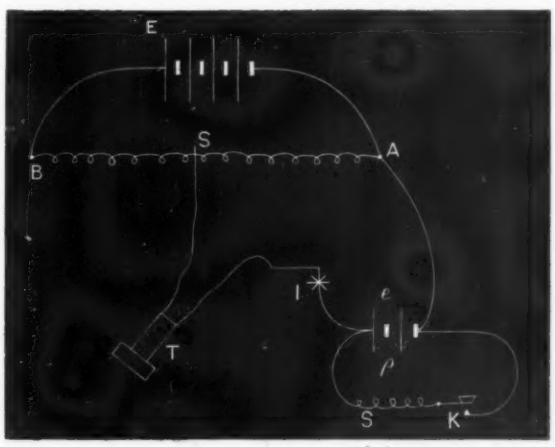
$$f = 0{\cdot}233,\ \mathrm{P}_i = 75{\cdot}0.$$

(To be continued.)

A METHOD OF MEASURING THE INTERNAL RESISTANCE OF A BATTERY BY MEANS OF A TELEPHONE.

By E. C. RIMINGTON.

LET e be a battery whose internal resistance, ρ, is to be determined. Circuit a battery, E, of higher E.M.F. than e through a slide resistance, A, B, on which moves



a slider, S. T is a telephone, I a rapid make and break interrupter, S is a resistance through which e can be circuited on depressing the key, K. Move the slider until there is silence in the telephone, K not being

depressed ; let D be the division on the slide resistance at which S stands when this is the case, the zero division being at A. Then, since no current passes through the telephone, the potential difference between A and S is equal to the E.M.F. of e, which we will call e. The potential difference between A and S $= a$ D, a being some constant. So a D $= e$. Depress K and move the slider until silence is again obtained, let its position be at the d division. Then, by Pollard's theorem of a shunted battery, $a\,d = \frac{e\,S}{\rho + S}$

Therefore $\frac{D}{d} = \frac{\rho + S}{S}$ or $\rho = S \cdot \frac{D - d}{d}$.

If e be a battery much subject to polarisation, a little difficulty will be found in determining the position of d, but, by moving S until a place is found which gives silence at the instant of depressing the key, though this silence may be almost immediately followed by sound, the value of d can be determined with a fair degree of accuracy.

EXPLORATIONS OF THE MAGNETIC FIELDS SURROUNDING DYNAMOS.

DURING the Electrical Exhibition at Philadelphia in 1884, the writer (Carl Hering, in the New York *Electrician and Electrical Engineer*) had occasion to examine the large Edison dynamo, commonly known as "Jumbo," with a view to find what disturbing effect, if any, the iron of the direct coupled steam engine had upon the distribution of the magnetism of the two pole pieces, it being attached to one of them. The examination was directed to finding the position, polarity, and approximately the intensity, of magnetic poles on different parts of the engine and pole pieces. By the somewhat strange behaviour of the exploring needle, the writer's attention was called to the peculiar distribution of the magnetism around the yoke piece and parts of the coils of the dynamo itself where it was apparently not affected by the engine. The peculiar results obtained in some parts led to a similar examination of other machines at the exhibition with a view to making diagrams of the magnetic fields surrounding the dynamos by plotting the direction of the external lines of force. The resulting diagrams were not only interesting but may also prove to be instructive to designers and builders of dynamos, as they show clearly and conclusively the nature of the invisible field surrounding the different parts of the magnets ; and as a large part of this field is leakage or wasted magnetism, they show how frames should and how they should not be constructed with reference to magnetic distribution.

The tests were made as follows :—The exploring needle, which may be termed a "magnetoscope" or indicator of magnetism, as distinguished from a "magnetometer" which measures the quantity, was an ordinary short, light, compass needle, strongly magnetised and loosely supported on a pivot. While the dynamos were running and the magnets fully excited, this needle was moved about in the space surrounding different parts of the magnets and the machine frame. If the case containing the needle be turned so that the needle is always perpendicular to its pivot, thus allowing it to turn as if on a ball and socket joint, the needle will take the direction of the lines of force in this space. By moving it systematically all around the differents parts of the machine, and by plotting the direction of the needle on outline drawings of the machine, the directions of the lines of force may be readily indicated. To explore the curved paths of the lines of force the needle may be held near to any particular part of the frame and then moved continually in the direction in which the farther ends point, that is as the direction of the needle changes the direction in which it is moved must be changed so as always to conform with that to which the needle points. The path which it describes will then be that of the particular line of force. In this way the curvature and the two terminals of an external line of force can readily be determined and plotted with all due accuracy, as the needle is always a tangent or short chord to that curve, and where the needle points directly to the iron when held closely to it, it indicates the point where the line enters or leaves the iron. By shaking the needle to cause it to oscillate, a rough approximation can be obtained of the intensity of the field or the number of lines of force at different places. Great care should be taken not to move the needle too fast, as the lines of force in some machines make such short curves that the needle is demagnetised and even reversed in polarity before it has time to turn on its pivot. It is necessary, on account of this possible reversal of the magnetism, to test frequently its polarity at one of the machine poles, otherwise very queer and conflicting curves may be obtained.

The polarity of a magnet being usually represented by the signs + and −, the former indicating the north or north seeking pole, and the latter the south or south seeking pole, the direction which the external lines of force are conventionally assumed to have, is from + to −, that is, as if they emanated from the north pole of a magnet. If the compass needle or magnetoscope has an arrow head on its north end, the direction of this arrow will always show the direction of the lines of force of the field which is being explored.

It will greatly facilitate the examination and plotting of these curves to remember that every line of force appears to make a closed curve which encircles the wire through which the exciting current flows. This will also enable one to interpolate the probable return paths of the lines in the iron where their presence cannot be ascertained by means of a needle otherwise than by their external manifestations. All lines which do not pass from the pole pieces to the armature core and are therefore not cut by the armature coils, are wasted and represent leakage.

In the accompanying diagrams the probable return paths of a few of the lines of force in the iron parts have been indicated, and it is believed they are correct. The drawings may not in all cases represent the exact proportions of the frame, as they are copied from mere rough note-book sketches.

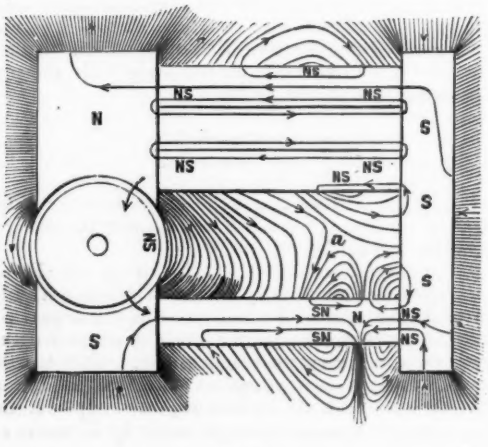


FIG. 1.

The first machine examined was the large Edison "Jumbo." Fig. 1 shows the results obtained, copied from the rough sketches. As is well known, the frame of this machine is unsymmetrical, consisting of two horizontal sets of cylindrical, parallel magnets in the upper part, and one set in the lower. Each set consisting of four magnets, there were altogether eight magnets in the upper part and four in the lower. From this unequal distribution alone, it might have been supposed that either there would be considerable leakage

of the excess of magnetism of the upper sets of magnets, the lower ones presenting only half the cross-section of iron, or that if the upper ones were only half saturated in order not to over saturate the lower, there were more magnets in the upper part than required to produce the needed magnetism. The coil of each lower magnet was found to be connected in series with the two above it, thus forming a series of three coils; these series groups were then connected in multiple arc with one another, forming a series-multiple group of three in series and four in multiple. If, therefore, the number of turns of wire was the same in each of the upper and lower coils, the upper half of the machine must have received twice the amount of magnetism that the lower had. From the external lines of force this appears in a measure to have been the case. The exploration of this field showed a somewhat peculiar distribution of magnetism which it was at first thought might be due partly to reversals of polarity of the exploring needle, but repeated examinations during which the needle was frequently tested for polarity, showed that the results were quite correct, as might have been shown *á priori*, had it been known that the total ampère-turns in the upper part were much greater than those in the lower.

Beginning first with the upper pole-piece marked N, the usual intense leakage was observed on the surfaces and at the corners, and especially at the pole-piece projections, magnetically shunting the armature. Passing next along the upper magnet the first neutral point marked N S, was found beyond the middle, the lines of force on the other side of it, entering instead of emanating from the cores, as before. Passing next to the upper end of the yoke-piece a strong south pole was found. The lower one of the upper magnets was found to be similar on its lower side, to the upper side of the upper magnet, only that the neutral point was nearer the yoke-piece than before—neutral point being understood to mean a point where the two poles are exactly equal in intensity and where, therefore, the external lines of force are parallel to the cores. In a normal, straight bar magnet, the neutral point will always be in the middle, and might be termed the magnetic middle of a magnet, which in a normally proportioned bar magnet should coincide with its linear, axial middle.

In the space between these two upper parallel magnets, it was found that the lines of force were quite straight along their whole length, and parallel to the magnets, but in the opposite direction to their course in the cores. In other words, these two like magnets were neutral along their whole length on the sides facing each other. This might be considered as another proof that in two such parallel like coils ending in the same pole-piece, those parts of the coils which are nearest each other neutralise one another as far as the useful magnetism of the pole-piece is concerned; it will be noticed that these parallel lines of force when continued, as shown, through the cores, encircle those portions of the coils.

Passing next down the yoke-piece it was found that instead of being neutral in the middle, as usual, with poles at each end, it was a strong south pole along its whole length with no signs of a neutral point at any place. This is no doubt accounted for by the great excess of magnetism of the upper magnets over that in the lower.

The south or lower pole-piece was quite similar to the north, showing the usual intense leakage on all sides and corners and especially at the pole-piece projections.

Passing finally to the lowest magnet a very peculiar result was obtained, which was at first discredited, but upon repeated and careful exploring it was found to be verified. A short distance from the right hand end there was a very intense north pole, the lines of force being at that point quite perpendicular to the coil for a short distance, as shown, and afterwards branching out to the right and left, finally entering the iron again. Between this point and the yoke-piece there was, of course, a neutral point marked N S, and on the left hand side, also quite near to it, another neutral point of opposite polarity, marked S N. These two neutral points situated so very near a strong pole, created a very curious field, the most interesting part of which is that lying above them where the lines come together with those of the magnet above it. At this point, *a*, it will be noticed that the lines which come together make four sharp turns as though there was something at this point which did not permit the lines to pass through but which reflected them somewhat as rays of light are reflected from a mirror. A needle held at this point acts as though it were uncertain in which direction to point, and if moved about this point even for very short distances, it will have very decided but quite different directions, as will be seen from the arrows which show the direction of the needle when in the respective lines of force. If a very short needle could be placed exactly at this point it would act similarly to a body balanced in unstable equilibrium, the slightest movement from this position causing the needle to deflect in a certain definite direction. Such points might therefore be termed "points of unstable magnetism," or "points of magnetic deflection having four poles," as there are four general directions of the lines of force in the vicinity of this point. Their characteristic peculiarity is that the needle is very apt to have its polarity reversed when moved through them, the explanation of which is, no doubt, that the lines of force make such abrupt curves that their direction through the needle is reversed before it has time to turn on its pivot.

In a few places the probable courses of the lines of force through the iron itself, have been indicated. It is not possible to determine this definitely with the aid of a needle only, but from the nature of the field surrounding the iron and from the general laws of lines of force, it is very likely that the courses indicated are correct.

From the results obtained in the exploration of the field of this dynamo, the following conclusions may be drawn:—Two similar parallel magnets, like those in the upper part, ending in the same pole and yoke-piece, are not to be recommended, as there is considerable leakage between them. When the general form of the magnets for a dynamo is that of a simple U-magnet, it should if possible be symmetrical magnetically as in an ordinary horse-shoe magnet. The magnetism of that part of the lower magnet between the letter *n* and the yoke-piece, is in the opposite direction to that generated by the ampère-turns on this part, from which it appears that the magnetism from a certain number of ampère-turns on other parts of the magnet is consumed in first neutralising that in this part and then reversing it; it appears from the strong north pole on the lower magnet that the economy in the magnetism from the ampère-turns is poor, the reason being apparently in the unsymmetrical distribution of the iron and coils. As most of the lines of force shown in the figure do not pass through the armature, they represent leakage or wasted magnetism.

Fig. 2 shows one-half of a normally proportioned Weston machine, the general type of frame being used also by numerous other makers. The field surrounding this frame appears to be quite symmetrical above and below, which in fact would naturally follow from the symmetrical distribution of the iron and the magnetising coils. The two neutral points on the upper and lower surfaces of the same magnet were not directly above each other, that on the outside surface being nearer the yoke-piece. Both the upper and lower coils showed strong poles at each end. The yoke-piece has strong poles at its ends and neutral points in the middle. No portions of the coils have reversed magnetism in them, which is no doubt due to the symmetrical distribution of the magnetism. A point of "unstable magnetism" or of "magnetic deflection" was found in this machine also, differing from the one observed in the Edison machine in the fact that the lines of force around it were symmetrically distributed. The general character of the field at such a point is more clearly shown in this machine. The upper and

lower lines of force having opposite directions or opposite polarity, will, according to the laws of lines of force, attract each other, forming sharp curves at their nearest point; the same is true of the lines on the right and left hand sides of this point thus forming the four curves shown. The field at this point is similar to that produced by four bar magnets placed in the position shown, the opposite ones having like poles toward each other. It will be noticed that this point is bounded by four neutral points (one of which is in the armature) alternating with four poles, the successive neutral points and poles being alternately of opposite polarity, a neutral point being considered to be a point in the magnetic circuit around which the external lines of force are parallel to the axis, as described before.

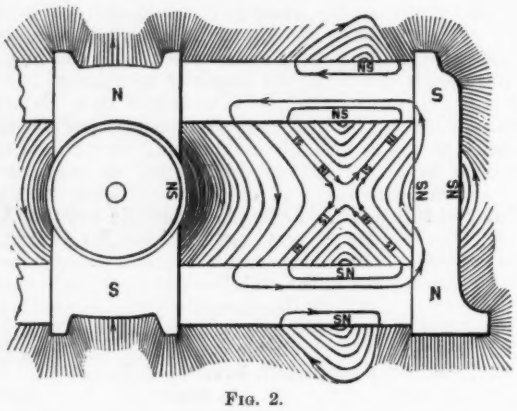


FIG. 2.

This is also true of that point in the Edison machine, only that the distribution is not as regular as in the Weston. In both these machines, and probably in all others having such U-magnets with two coils, the complete iron circuit of the useful lines of force, beginning at one pole-piece thence successively through one magnet, the yoke-piece, the other magnet, the other pole-piece, and finally returning through the armature, includes four alternately opposite poles, separated by four neutral points of alternately opposite polarity, the polarity of the neutral points being indicated by N S, or S N, respectively. If the entire U-magnet were made in the form of a circle wound over its whole length with coils, like a Faraday induction coil, and cut at one point for inserting the armature as in the Sir William Thomson and the Mather machines, it is possible that this succession of poles and, therefore, also the point of magnetic deflection, would disappear.

(*To be continued.*)

TECHNOLOGICAL EXAMINATIONS.

IN our issue of the 22nd ult. we gave the Science and Art Department's examination papers on magnetism and electricity, and we now print those of the City and Guilds of London Institute for the advancement of technical education on telegraphy, electric lighting, and transmission of power and electrical instrument making, and request remarks from teachers and students.

22A.—TELEGRAPHY.

Ordinary Grade.

1. Explain why the instruments used for working on aerial lines are unsuitable for use on long submarine cables.
2. Distinguish between "open" and "closed" circuit working in telegraphy.
3. Describe the bichromate battery, and explain its chemical action.
4. A telegraph line, 50 miles long, has a resistance of 12 ohms per mile, and an instrument of 400 ohms resistance is placed at its end: what current will 10 Daniel cells (of negligible resistance) send through the instrument?
5. What advantage is gained by using an earth instead of a return wire in telegraphy?
6. State the various units used in electrical measurement, and show how they are related to each other. [This is surely an Honours question, if it has to be answered at all completely and accurately.—EDS. ELEC. REV.]
7. Describe any test by which the resistance of a battery may be determined.
8. What is meant by the electrostatic capacity of an insulated wire, and how may it be measured?
9. Describe and illustrate the general construction of a single needle telegraph instrument.
10. How are iron telegraph wires jointed? [We have never yet seen a question given in the telegraphy examination on the important subject of jointing submarine cables? Why is this?—EDS. ELEC. REV.]
11. Describe any form of lightning protector used for protecting telegraph apparatus.
12. Two Bell telephone instruments are connected together by a telegraph wire. Explain the action which takes place when one of the instruments is spoken into.

Honours Grade.

1. Describe in detail the construction of the Morse printer, and explain the various adjustments of the instrument.
2. Why is it that greater speed of working is attainable on overhead than on underground or submarine wires?
3. The distance between two telegraph poles is 100 yards, and the dip or sag is 24 inches; what sag should be allowed in order that the wire may have the same strain upon it when the poles are 80 yards apart?
4. Sketch and describe the general system of underground wires adopted in this country.
5. Describe any form of switch board in use at telephone exchanges.
6. A Daniell battery in use at a telegraph office is found to give a weak current; to what causes may this be attributed, and how would you proceed to discover what is wrong?
7. A cable whose conductor resistance when perfect is 1,000 ohms becomes faulty, and the resistance measured from the nearer end when the further end is insulated is found to be 900 ohms; when the further end is put to earth then the resistance measured from the nearer end is found to be 820 ohms; determine the position of the fault.
8. Contrast the relative advantages of "open" and "closed" circuit working.
9. How may the individual resistances of three telegraph lines running between two stations be determined without using earth?
10. How would you determine the specific conductivity of a piece of copper wire?
11. Two wires, both insulated with the same material, have their respective conductors and insulators of different diameters; what would be their relative inductive capacities?
12. Discuss the relative advantages of the "differential" and bridge system of duplex telegraphy.
13. What is the "time constant" of an instrument? and explain why a greater number of currents can be sent in a given time through a copper than through an iron wire of similar diameter and length.
14. Describe the microphone and the principle of its action.

22B.—ELECTRIC LIGHTING AND TRANSMISSION OF POWER.

Ordinary Grade.

1. The resistance of a copper wire ·134 inch in diameter and 1,760 yards long is 3·128 ohms. Calculate the resistance of 440 yards of a wire of the same metal ·065 inch in diameter. What will be the joint resistance of these two wires if joined in *multiple arc*?
2. The current through a carbon filament glow lamp is ·65 ampère, and the electromotive force operating it is 130 volts. What is the resistance of the lamp when working? How does increase of temperature affect the resistance of carbon? Is it similar or different to metals in this respect?
3. A current of 10 ampères flows through a copper wire of 100 ohms resistance. Assuming that 746 watts are equivalent to one horse-power, state at what rate energy is being expended in this wire, and give your result also, if you can, in foot-pounds per second.
4. Give a careful sketch showing the mode of winding a Gramme ring armature, and the mode of connecting the armature wire to the commutator bars. How should the commutator bars be insulated?
5. Dynamos are classified into *shunt*, *series*, and *compound*, according to the mode of winding and connecting up the field magnet circuits. Give sketches to illustrate each mode, and explain very shortly their relative advantages.
6. You have to set up a plant consisting of glow-lamps worked by secondary batteries and a dynamo. What kind of dynamo would you employ? Give sketches to show how you would arrange the appliances, and state the number of cells required to work 50 volt glow-lamps, assuming them used close to the battery.
7. Sketch some form of arc lamp regulator, and describe the mode you would adopt to measure the candle-power of the arc, and the absorption of electrical energy required to produce the light. [This might with advantage have been divided into two or three separate questions. It is a great mistake to ask too much in one question, especially in an elementary paper. —EDS. ELEC. REV.]
8. By what means can power be electrically transmitted? If a circular saw has to be worked by a water-mill at some distance from it, how is it possible to effect this electrically? Sketch the arrangement you would propose to use.

9. Explain the difference between a *primary* and *secondary* battery. What is meant by *local action* in a battery?

10. Why cannot a series dynamo be advantageously used to charge secondary batteries?

11. Describe some good form of instrument for measuring the strength of an electric current of about 1-10 ampères.

12. What is a wattmeter? Sketch some form of the instrument, and explain its use.

13. What is meant by the term *a line of magnetic force*? How can the lines of force of an ordinary steel bar magnet be delineated? Sketch the form they assume in the case of a bar, and a horse-shoe magnet respectively.

14. The iron cores of armatures in dynamo machines are generally made of a number of thin plates of iron, and not of one solid mass of iron. Why is this?

Honours Grade.

1. State the laws of current distribution in divided circuits. Twelve wires, each of one ohm resistance, are joined up to form a skeleton cube. Show that the resistance between diagonally situated corners is five-sixths of an ohm. [The latter part of this question appears to be rather theoretical, and more suitable for the Honours Science and Art Examination.—EDS. ELEC. REV.]

2. If currents are flowing in a network of conductors, explain the means by which the dissipation of energy in horse-power can be calculated. Explain fully what rule should, according to Sir W. Thomson, determine the size of the conductors in any system employed for distribution.

3. Define the term *specific resistance*. Explain fully how you would proceed to determine the specific resistance of carbon of such quality as is used in arc lighting. Is it possible by any means to construct a resistance which is unaffected by moderate change of temperature?

4. Give a careful explanation of what is meant by *self-induction*. Is the self-induction of a circuit the same for steady currents and for rapidly alternating currents? If not, state how it is different. Are there any facts which would lead you to prefer a copper rather than an iron wire for telephonic purposes?

5. You are required to report on some samples of iron furnished to you as intended for field magnets of dynamo machines. State the experiments you would make, and what is the special quality you would desire to find present in order to approve of a sample as good.

6. Explain the structure of any practical form of *secondary generator*, and say whether, and why, you would design a secondary generator with a closed rather than an open magnetic circuit.

7. Give an explanation of a method for determining the commercial efficiency of a continuous current dynamo. Describe the principle of Dr. Hopkinson's method of measuring the combined efficiency of a dynamo and identical motor, or any modification of the method since suggested.

8. You are given a commercial ampèremeter to test and standardise. Explain how you would propose to do it.

9. The secondary current from an induction coil is passed through a long helix of wire, and through a Bell telephone in series with it. The telephone emits a continuous sound. What effect, if any, should you expect to be produced by introducing a bundle of iron wires into the helix, and why?

10. Explain the construction of a Pilsen arc lamp. How can arc and glow lamps be run on the same circuits?

11. How is pure copper prepared electrolytically? [Is this an electric lighting or transmission of power question?—EDS. ELEC. REV.]

12. Explain the principles of any form of practical power-meter for measuring electric power expended in any circuit.

13. Explain the reasons for the counter electromotive force developed by a motor when running. If a shunt-wound motor is being worked at constant potential, describe some means by which the direction and speed of revolution may be controlled by an operator using it, according to the nature of the work being performed.

14. Can one alternate current dynamo be driven as a motor by another identical machine? If so, state how you would arrange and join up the machines. Give a full reason for your reply.

[What we feel after reading and carefully considering the above Honours paper is this—viz., that a person who never helped to make or design a dynamo or motor, and who never fitted up, designed, or worked an electric lighting and transmission of power circuit, might pass if he had simply attended a good course of lectures, whereas, another person who was intimately acquainted with the practical designing, making, and working of these things, might fail to please the examiner. We would suggest, therefore, that the questions in future should demand a more thorough and practical knowledge of the subject, if the certificate and diploma is to be considered of value by electrical engineers and employers of labour. After all, it comes to this: young men attend lectures, read books, and work hard for these examinations, not for mere pleasure and enjoyment, but in order that they may secure appointments and gain higher salaries. It is therefore extremely desirable that employers should be made to feel that the passing in Honours really means that the student does know his subject, and will be of value in designing and carrying out work.—EDS. ELEC. REV.]

22c.—ELECTRICAL INSTRUMENT MAKING.

[We had occasion to criticise the style of questions given last year in electrical instrument making. We are glad to observe a decided improvement in them this year.]

Ordinary Grade.

1. You have to make a horse shoe permanent steel magnet. Describe the process of making, hardening, and magnetising. Show how by means of iron filings you would investigate this uniformity of magnetisation. Explain the object of providing the magnet with a "keeper."

2. Prepare a design for a mirror galvanometer of high resistance. Describe the winding and insulation of the coils. Galvanometer coils are sometimes wound on copper frames. Why is this?

3. You have to make a small electro-magnet for an electric bell. Sketch the arrangement you would employ, and the mode of winding the coils. Show how to determine the direction of the current in the wire of the electro-magnet, having only a pocket compass at command.

4. Describe with sketches the construction of a small induction coil. Why is it necessary to use an iron core of fine wires rather than a solid bar of iron?

5. What is a tangent galvanometer? How should the scale of such an instrument be divided so as to make its sub-divisions of equal value in indicating increase of current in the coil.

6. You are required to make a gold leaf electroscope. Describe all the precautions necessary to make a successful and delicate instrument.

7. Give a diagram representing the arrangement of parts in a simple quadrant electroscope of Sir William Thomson's pattern.

8. Describe the construction of a standard resistance coil of about 1 ohm. State what material you would select for the wire, and the mode of winding and insulating it.

9. You are required to make a small Wheatstone's bridge, suitable for workshop use, for comparing the resistances of wires. Give a sketch showing the form in which you will make the instrument, and the process you would employ to compare the resistance of a given wire with that of a known standard resistance.

10. Describe exactly how you would construct a condenser, such as is required for a small induction coil, and how you would attach it to the coil.

11. You are given several samples of wrought and cast iron. How would you proceed to test them to ascertain which is most suitable for making the field magnets of a small dynamo?

12. Give with full sketches the arrangements required in fitting up a house with electric bells, and describe the mode of making the Leclanché cells generally used for this purpose.

13. You are required to make a very small resistance, say $\frac{1}{100}$th of an ohm. State how you will do this accurately, and how by means of such a resistance and a galvanometer capable of measuring only small currents, a very large current can be measured.

14. Describe the construction of some form of commercial voltmeter suitable for measuring the electromotive force of alternate currents. What error is introduced into the reading of most ordinary voltmeters by the heating of the coils by the current?

Honours Grade.

1. Given that one mile of pure copper wire, ·134 inch diameter, has a resistance of 3·128 ohms. Calculate the resistance of 440 yards of a wire, ·067 inch diameter, and having 95 per cent. conductivity.

2. You are required to wind over a brass tube, 500 centimetres long and 2 centimetres in external diameter, with one layer of covered wire, 1 mm. diameter over the covering. What length of wire will you require? What will be the strength of the magnetic field at the centre of the axis of such a helix when a current of 1 ampère flows through the wire?

3. Describe the construction of a condenser required for use as a standard of capacity, and the method by which you would proceed to determine its capacity in absolute measure.

4. You are required to construct a tangent galvanometer for measuring large currents. Explain what form you will give to the instrument, and show how the galvanometer constant may be experimentally determined.

5. Describe fully the precautions to be taken in winding the coils of a high resistance galvanometer to secure perfect insulation. How would you test such a coil for insulation?

6. Prepare a design for a resistance coil intended to carry large currents and yet have a very accurately determined value.

7. You are required to design a dynamo machine for electro depositing copper. Give a general description of the sort of machine required for depositing about 1 lb. of copper per hour. What current output will this require?*

8. In designing a lightning conductor, are there any reasons why you would prefer a copper tape rather than a round iron rod?

9. Describe how you would make and fit up a small set of Plantè secondary lead cells, and the operations you would conduct in order to "form" the plates.*

10. Give some sketches of the mode of gearing you would propose to use in transmitting the power of an electro-motor to the driving wheels of an electrically-driven tramcar.*

11. A time-ball has to be dropped by a standard clock at a distance. Illustrate in outline the mechanism required to do this.

12. Describe the construction of a Wimshurst electric machine, and explain fully the principle which underlies the action of all induction machines of this type.

13. You are required to construct a standard electro-dynamometer. Prepare designs for it, and state the precautions and measurements to be observed in winding the coils of such an

instrument in order that the constant may be capable of being determined by calculation.

14. Give a general description of any appliance with which you are acquainted, whereby the varying speed of an engine driving a shunt dynamo may control resistance in the field circuit, and preserve constant the electromotive force.*

*[Questions 7, 9, 10, and 14 appear to be more suitable for "Electric Lighting and Transmission of Power" examination paper than for electrical instrument making.—EDS. ELEC. REV.]

EVOLUTION OF THE ELECTRIC TELEGRAPH.

(*Concluded from page* 163.)

THE first line to be worked by magneto-electricity instead of galvanism, the first to have an existence, and a useful existence, of years' duration, and the system of which the majority of subsequent telegraphs were simply modifications, was that erected for quite other than telegraphic purposes by Gauss and Weber at Gottingen in 1833. In that year a double-wire line was led over the houses of the town from the Physical Cabinet to the Observatory, and later an addition was made continuing it to the Magnetic Observatory, a distance of a mile and a quarter. The line wire was "mostly" of copper, and the wires of the multipliers which surrounded the magnetic needles were also of copper. The purpose for which the line was set up was for the study of the laws of the intensity of galvanic currents under different circumstances on a large scale. Its usefulness for the transmission of signals soon became apparent, however, and it was frequently used for that purpose, one of its earliest applications being the regulation of the clocks at the Physical Cabinet and the Observatories. The arrangements used for the production of magneto-electric currents consisted of two or three large bar magnets fixed together in a vertical position, and a bobbin wound with some thousands of turns of insulated copper wire surrounding them at about their centre. This bobbin was furnished with handles, and when it was lifted by means of these handles, a momentary current was induced in the coil; on its being lowered again a current was set up in a direction opposite to the first. The two ends of the coil were connected to a commutator and thence to the line wires. The receiving instrument was a large coil or multiplier of insulated copper wire on a copper frame, a permanent steel magnet being suspended in the middle of the coil by a number of silk fibres from the ceiling of the room. Gauss and Weber formed an alphabet based upon an ingenious combination of the deflections of the magnet. To enable the observer to read off with care the small deflections of the magnet a mirror was so placed upon the shaft of the magnet that it presented the reflex of a horizontal scale, the observations being made through a telescope at a distance of 10 or 12 feet. This is the plan which Sir William Thomson has since adopted in his mirror galvanometers. In 1835 an alarum was added to the system, which, according to some accounts, consisted in giving to the magnet a wider swing than usual and so causing it to strike a bell; while, according to others, it was very similar to that of Schilling, the magnet, when largely deflected, upsetting a delicately poised lever in train with the detent of an ordinary clockwork alarum.

This line of Gauss and Weber was, as has already been stated, employed for scientific investigation and not for the development of telegraphic ideas. Believing, however, that the instruments possessed brilliant capabilities, Gauss, unable to spare time from his other labours to pursue the new suggestion, entrusted to Professor Steinheil, of Munich, the task of modifying the apparatus so as to adapt them to telegraphic uses. Steinheil entered upon his investigations, which commenced about the year 1836, with the utmost enthusiasm, studying magneto-electricity thoroughly, and making experiments, discoveries and suggestions which earned for him the name of the founder of electro-magnetic telegraphy. Highton, writing in 1852, said of this system that on the whole it was "a very perfect one and may well put to shame many of the plans afterwards patented in this kingdom." Steinheil was one of those rare men who are ever ready, and even anxious, to accord to others working in the same field with themselves the fullest credit and honour for their researches and inventions, even when such acknowledgment may seem to detract from the value of their own labours. He erected a line 12 miles in length at Munich in 1836, and writing respecting the changes he had effected in Gauss and Weber's apparatus, he readily admitted that to those men of genius was due the merit of establishing the practicability of the magneto-electric telegraph. The alterations which he had introduced, he added, might be said to be founded upon his perception and improvement of its imperfections. What he felt was required was an appropriate method of inducing or exciting the galvanic current, with the power of changing its direction without the need of any special contrivances, and a mode of rendering the signals audible. He devised methods of rendering the signals both audible and legible; but—and this may be mentioned as a further illustration of his grand sense of fairness—he admitted that Morse's sound method, when that was introduced 10 years later, was a great improvement upon his own, and used his influence to persuade the Bavarian Government to adopt it in preference to his own. We will here give a fairly complete description of Steinheil's telegraph. He employed a compound permanent magnet consisting of seventeen horse-shoe magnets, weighing together 60 lbs., and capable of lifting five times their combined weight. Two induction coils, having together 15,000 convolutions of insulated copper wire, turned on an arbor, and presented their axes in rotation to the poles of the magnet, so that when one coil was under the north end of the magnet, the other was under the south end. The commutator in connection with these coils was so constructed that, in turning them from right to left, the alternate currents, or all those going in one direction only, passed through the line, and, on turning them backwards, or from left to right, only those currents in the opposite direction were let into the circuit, the others being cut off. Steinheil was careful to admit his currents for the shortest possible space of time, and for this purpose allowed the contact springs of his commutator to make contact with the lines only at the moment when the induced current was at its maximum. The receiving apparatus consisted of an oblong coil of wire or multiplier of 600 turns, in the centre of which were supported, on vertical axes, two magnetic needles, their neighbouring ends having opposite magnetic polarity. To these ends were attached brass continuations with small ink reservoirs; these reservoirs were furnished with capillary tubes and filled with printer's ink, so that on coming into contact with a strip of paper travelling before them they each printed a dot. Two plates were so placed at the further ends of the magnets as to prevent them from being deflected in the direction opposite to that in which they were to print, and from thus, by oscillation, imprinting an unrequired mark upon the paper. A current sent through the coil deflected only one needle at a time, the other being held back; on the current being changed, the other needle only was deflected. Thus the signals on the paper were recorded in two lines, those to the right making the deflections in that direction, and those on the left indicating the left-hand deflections. The letters of the alphabet were constructed from combinations of at most four of the dots given in succession by the pointers of the two printing needles. Messages were sent with this apparatus at the rate of 92 words in a quarter of an hour, or over six words per minute. Telegraph engineers of to-day will perhaps be surprised to learn that Steinheil ran his wires in spans of from 200 to 400 yards. These great lengths, however, were only adopted under compulsion, and he pointed out the danger of a rupture of the line from the increase of weight

and diameter caused by the formation of ice upon it. In addition to his great services to telegraphy already recorded, Steinheil is entitled to further honour for having discovered—accidentally, it is true; but he was quick to perceive what another might have overlooked, and to apply his discovery practically—that it was sufficient to conduct the current to earth instead of employing a return wire. This was in July, 1838. Seven months earlier an Englishman suggested the possibility of such a plan in the *Mechanic's Magazine* (December 8th, 1837). "Corpusculum" there wrote:—"It seems many persons have formed designs for telegraphs. I, too, formed mine, and prepared a specification of it five years ago, and that included the plan of making one wire only serve for the returning wire for all the rest, as in Alexander's telegraph; *but even that might, I think, be dispensed with* where a good discharging train, as gas or water pipes, at each end of the telegraph could be obtained." Here we have a suggestion of the use of the earth in precisely the same way that it is employed to-day. In the period anterior to Volta's famous discovery, when static electricity alone could be employed for telegraphs, a single wire only was frequently employed, as we have shown, water or the earth being employed for the return; but the true function of the earth as part of the circuit was not then understood—indeed, the dual character of electricity was not yet fully comprehended—and Steinheil's was the first intelligent and practical utilisation of the earth in circuit. According to De la Rive, the discovery was made in this way:—"Gauss having suggested the idea that the two rails of a railway might be employed as conductors for the electric telegraph, Steinheil, in 1838, tried the experiment on the railroad from Nüremburg to Fürth, but was unable to obtain an insulation of the rails sufficiently perfect for the current to reach from one station to the other. The great conductibility with which he remarked that the earth was endowed, caused him to presume that it would be possible to employ it instead of the return wire. The trials that he made in order to prove the accuracy of this conclusion were followed by complete success; and he then introduced into electric telegraphy one of its greatest improvements." Having so far simplified telegraphy by rendering unnecessary a complete metallic circuit, Steinheil was led to speculate upon the possibility of a still further reduction in the use of wire—whether, in fact, telegraphing could not be carried on without wires. Having referred to his discovery already mentioned, he proceeds thus:—"The inquiry into the laws of dispersion according to which the ground, whose mass is unlimited, is acted upon by the passage of the galvanic current, appeared to be a subject replete with interest. The galvanic excitation cannot be confined to the portions of the earth situated between the two ends of the wire; on the contrary, it cannot but extend itself indefinitely, and it, therefore, only depends on the law that obtains in this excitation of the ground and the distance of the exciting terminations of the wire, *whether it is necessary or not to have any metallic communication at all for carrying on telegraphic intercourse.*" He made experiments which proved the feasibility of influencing a magnet through a distance of 50 feet, and there he apparently left the subject.

Dr. O'Shaughnessy (afterwards Sir William O'Shaughnessy Brooke), the organiser of the East Indian telegraphs, claimed to have independently discovered the earth circuit, and pointed for evidence to his paper in the *Journal of the Asiatic Society of Bengal* for September, 1839.

Whichever had been experimenting in private longest, Edward Davy was certainly before both Wheatstone and Cooke in making a semi-public exhibition of his telegraph, and in depositing a description of it. The idea of an electric telegraph first occurred to him about 1836, when he sketched out a plan to be worked by static electricity. For the sake of more readily illustrating his system, he spoke of using 24 wires, one for each letter of the alphabet, but he stated that six would be more than sufficient in practice, seeing that numerous changes might be made upon them by combination. To each wire was attached a key, on pressing which connection was made by means of a mercury cup, into which the wire dipped, with the source of electricity, the prime conductor of an electrical machine, or a powerful electrophorous. A spark was thus transmitted, and was reproduced at the distant end of the line, where a light suspended ball was first attracted and then repelled, the latter action exposing the letter to which the particular wire related. A little later he drew up proposals for a telegraph, based upon the electro-magnetic qualities of the voltaic current. The best source of electricity he considered would be either one of Daniell's constant-current cells, then just discovered, or a magneto-electric machine. Connection with the source of electricity was to be made in a similar manner to that just described. Each line wire was to terminate in another of smaller size, formed into a rectangular coil of from five to 200 turns, according to circumstances. All the coils were to be ranged in a row in the magnetic meridian, and in each was to be suspended a delicate magnetic needle. The whole was then to be covered by a board, the straight edge of which just concealed the needles in their position of rest, but, on any of them being deflected, allowed one end to project, and so exposed the letter marked upon it. Very important improvements were effected in quick succession, and at the commencement of 1837 his apparatus was so far complete that he was able to submit it to the test of actual experiment. He obtained permission to lay down a mile of copper wire around the Inner Circle of Regent's Park, and through this he performed many successful experiments. In March of this year, hearing that Professor Wheatstone was engaged on an electric telegraph, Davy, in order to ensure his priority, lodged a *caveat*, and deposited with Mr. Aikin, the secretary of the Society of Arts, a sealed description of his invention. About this time he added to his system the relay, or "electrical renewer," as he called it. He refers to his discovery of the usefulness of this contrivance in these words: "It then [after his Regent's Park experiments] occurred to me that the smallest motion (to a hair's breadth) of the needle would suffice to bring into contact two metallic surfaces so as to establish a new circuit dependent on a local battery; and so on, *ad infinitum*. In Cooke and Wheatstone's first patent there is a proposal to produce a powerful alarum by striking a bell through the intervention of a local battery; but not a word about any reverser, or relay, as applicable to general electric telegraphy. . . The principle of the relay rendered demonstrably practicable the system of overland communication by electricity over unlimited distances." Davy opposed the applications of Cooke and Wheatstone in 1837 and Morse in 1838, for patents. In the document containing a full description of his improved form of telegraph which he lodged with the Solicitor-General when opposing Wheatstone and Cooke, he speaks of twelve needles for indicating the signals, four pairs being letter needles, one pair colour needles and one pair alarum needles. The alarum was given by the explosion of fulminating silver placed on a card and swung into a flame, or the heat of a lamp, by the deflection of the needle. The letter and colour needles were used in combination according to a code. Eight conducting wires were used, and one return wire. During the summer and autumn of 1837, Davy effected further important changes in the mode of making signals, which increased the rapidity with which a message could be transmitted and read off. The colour needles were discarded. The others were all suspended so as to turn vertically instead of horizontally. The letter ends were weighted so as, under ordinary circumstances, to dip under cover, but on the passage of a current they were raised so as to bring the letters opposite an illuminated sight groove. What used to be the colour needles were now provided with small screens, which could be raised or depressed, in front of the letter needles, so as to conceal or expose them at pleasure. By means of this arrangement, Davy says, the limit in speed appeared to be

the quickness with which the eye could catch the letter and the hand note it down. A further improvement consisted of making the letters immovable and covering them by three screens in such a way as to be able to expose any desired letter at will. A working model embodying all the author's improvements to date was shown about November or December, 1837, at the Belgrave Institution, London, and from the great interest which it there excited Davy resolved upon a more public exhibition; accordingly he rented a room for one year in Exeter Hall, and there installed his telegraph from December 29th, 1837, to November 11th, 1838. Davy also patented a form of recording telegraph by electro-chemical decomposition, which he believed was calculated to supersede all others. That it has not done so we well know, and we also know that in the patent litigation which ensued in the year following Davy did not get the best of the contest. In regard to his opposition to the application of Wheatstone and Cooke, the Solicitor-General held that the two inventions were different. Davy endeavoured to get his inventions adopted, and at one time they were on the point of being put into use by more than one railway company; and, says Fahie (who had access to a vast store of Davy's private letters and documents), "had he stood his ground but six months longer, there can be no doubt that it would have gone hard with his rivals, Messrs. Cooke and Wheatstone. But, alas! just as his labours seemed on the point of fruition, private affairs, which we can never cease to deplore, drove him from England, and, of course, left them an easy triumph. Davy sailed from the Thames for Australia on April 5th, 1839, and, amid the new cares of a somewhat unsettled colonial life, soon forgot all about the telegraph." We may add that Davy is still alive, though over 80 years of age, and is greatly honoured in the Australian town which he has made his home. He still carries on his practice as a physician, and has several times been elected Mayor of the town. Within the last few years his work in connection with the telegraph has become more and more recognised, and although he has reaped very scant reward in a monetary sense from his ingenious plans, he has the satisfaction in his old age of seeing the realisation of some of his early dreams in the extended use of the telegraph.

We have come now nearly to the end of our narration. There remain to be mentioned, of the inventions of the year 1837 and earlier, those patented by Morse and by Cooke and Wheatstone. But of these no detailed description is necessary, for they, or modifications of them, are in constant use all over the world at the present moment. The instruments with which Wheatstone and Cooke conducted their first experiments were not the efficient apparatus with which we are now familiar; but they contained the germ which the patient, unwearying industry of a band of telegraph men has gradually developed into instruments of almost miraculous powers and of incalculable service to the State and to the individual. There have been a host of inventors since that eventful year, 1837; but these and their work pertain to another branch of the subject than that with which we set out to deal. We cannot put aside the pen, however, without recording our belief that the triumphs of the telegraph, as we know it, are as much the result of the mechanician's skill as of the electrician's genius. Granting to Sir Charles Wheatstone all credit for having conceived the ideas which led to the construction of the A B C instrument and the automatic fast-speed apparatus, it must yet be asserted that those ideas would never have had the grand realisation of which we are witnesses to-day had the work of construction been entrusted to other hands than those of Mr. Augustus Stroh, whose marvellous skill as a mechanician enabled him to produce, upon the suggestion of Sir Charles Wheatstone, instruments which were wonders of precision and which effected the desired operations in a simply perfect manner.

It has been the object of these articles to recall attention to some of the less-known workers who have been undeservedly overlooked in the apportionment of fame and honour among the more brilliant lights of the telegraphic firmament. It is hoped that in doing justice to these, no slight has unintentionally been cast upon others who are or have been deserving of praise and thanks. If by any mischance injustice has been rendered, or inaccuracy has crept in, our minds and our columns are open, and we shall be glad to publish information upon the subject not generally known.

ANOTHER PLEA FOR TECHNICAL TRAINING.

THE perversion of human intellect for the want of technical training has seldom, if ever, been so forcibly brought before us as through the medium of Scarlett's electro-motor which we recently examined. The invention is described as being the outcome of the perseverance and study, extending over a number of years, of one of Liverpool's working mechanics, whose object has been the production of an electro-motor without field magnets, and that would at the same time act as a generator. That the inventor who explained his apparatus to us is thoroughly in earnest, we cannot doubt, and his downright honest convictions respecting electrical science appear to be too firmly rooted to be readily upset; but a more pitiable case of misguided ingenuity it has rarely been our lot to witness. Briefly stated the motor shown to us consists of 11 coils or solenoids, arranged in a circular framework; passing through the centres of these coils is a metal ring made up of alternate sections of brass and iron. A strap or gut band gears the ring to a small pulley above the framework, and also supports the ring freely in the coils. A current from any source of electrical energy is passed into the coils in succession, and the iron portions of the ring are sucked into the coils in rotation, a rotary motion being thereby obtained. Of the details of construction, which are highly ingenious, we need not speak, but we must not omit to state that each coil has six double spring contacts, three on each side, making no less than 66 contacts, somewhat of the trembling bell form, to keep in order, besides others on the ring itself. The weight of this wonderfully complicated and marvellously designed apparatus is probably over 30 lbs. and its ring diameter 8 inches. Mr. Scarlett thinks it would make a good dental engine; so does a Griscom motor, and a comparison of the two does not show Mr. Scarlett's machine in a favourable light, either electrically, mechanically, or commercially. No tests of its efficiency, a very doubtful possession, have yet been made, but with 20 bichromate cells, quart size, the ring has been made to revolve at 100 revs. per minute, a result which means nothing, for in any case the motor cannot work for any time as constructed. We may add that Mr. Scarlett thinks it perfectly unnecessary that steam engines should be any longer used for driving dynamos for turning motors; and he intends to employ secondary batteries to run his apparatus, part of which, acting as a generator, will recharge the cells at the same time as the motor work is going on. The apparatus has apparently been shown at the Jubilee Exhibition held this year in Liverpool, and the perverted ideas of the inventor may be partly gathered from the following extracts culled from his pamphlet descriptive of the motor:—

"It will be obvious to all scientists and electricians that the coils must be made of a large foot-grain wire before there is a strong secondary current." "A dynamo wound with a small foot-grain wire, and propelled at a high rate of speed would give but a very imperfect light, but if wound with a large foot-grain wire would give off a great quantity." "These motors will be suitable for stationary engines for driving machinery; as an instance of where they could be used with advantage in the place of steam I will mention the underground railway of London, and instead of the atmosphere being poisoned by gases it is rendered more pure by the ozone given off by these motors." "The inventor has received the congratulations of leading electricians who have very

carefully examined the machines." Now if this latter statement is correct, these "leading electricians" ought to be thoroughly ashamed of themselves, for it is from the want of a timely check that many an honest, hard working mechanic is led on from year to year in pursuit of an *ignis fatuus* which eventually ruins him in both health and pocket.

If Mr. Scarlett's advisers had possessed a "foot"-grain of common sense, his evident ingenuity might possibly have been turned to a profitable account in other directions; as it is, his time, money, and energy have been absolutely thrown away, and his apparatus provides us with one more example of the truth of that old adage, "a little knowledge is a dangerous thing."

We were much prepossessed with the evident sincerity of Mr. Scarlett and his unfaltering belief that he had achieved a notable improvement in electromotors, and in a corresponding spirit of sincerity we would ask him to stay his hand and to proceed no further with a delusion which does not contain even the germ of success. Independently of all this, the principle he is working upon is very old, and if he is desirous of obtaining distinction in the electrical world at some future period he should first of all make himself acquainted with the innumerable visionary schemes which have been already tried and abandoned, devoting himself at the same time to a course of technical training.

THE BLACKPOOL TRAMWAY.

FROM the correspondence published last week in our columns it will be seen that the breakdown of the electrical working of the Blackpool Tramway is ascribed entirely to the failure of the insulators; but, according to information we have received from eye-witnesses, expansion has had a great deal to do with the stoppage. The statements contained in Mr. Holroyd Smith's extraordinary and *invaluable* report disclose a state of affairs almost incredible, and which can be but slightly realised even when it is known that there was a total absence of any kind of technical supervision whatever on the Blackpool system.

The manner in which the broken insulators have been removed, and their places unfilled seems to have been known to the managing director, and allowed to go on until such time as a total stoppage rendered some action necessary, and Mr. Smith was sent for. It may well be asked why was not some such step taken earlier, but we suppose that it was considered only necessary to look after the receipts, and that the line would look after itself.

This tramway has made history very rapidly, and we cannot help contrasting the present outlook with the situation at the time of the second annual meeting on the 27th November last. At this meeting a special vote of thanks was moved for the past services of the managing director. Mr. Broadbent, in replying, is reported in the local paper to have said "they all knew that twelve months since they dared not think what was before them, and he could tell them it had been extremely uphill work to bring the company to its present position." "They were told some time back that the company would never be able to run from one end to the other, but they made up their minds that it should go, and go it did. He could tell them they would have a better dividend next year, for now they were making things for themselves at a cost of about 5s. which previously they had to pay £1 or 25s. for, and they had also got over the difficulty of carrying a weight in a satisfactory manner." Later on the managing director was good enough to show how the company had been *saved the expense of an electrician*. We wonder how the directors will be prepared to meet the shareholders at the next annual meeting and justify the economic action which has helped to retard what promised to be a remunerative concern.

Setting on one side the question of material employed, and various defective arrangements, there can be no doubt whatever but that the present disastrous state of affairs has been brought about by the suicidal policy of the directors in leaving the management of the line entirely without any technical assistance. Even an ordinary telegraph inspector or lineman would have had the common sense to have known what was required to be done when insulator after insulator failed. Such stupendous stupidity is without parallel; and this was the electric tramway that was to be the pioneer of similar lines throughout the kingdom.

One word about the insulators which have been allowed to bring the line to grief, as their history furnishes some matter for consideration and thought. In the specification for the electrical work the following occurs:—"The insulator to be of porcelain, or other material of a nature to stand changes of temperature, action of sea water, and vibration. The insulating property must be such that when a mile of track is laid the resistance shall not be less than 1,000 megohms." This was the specification of Mr. Holroyd Smith, the patentee, and also engineer of the line. The contract for all the electrical work was given to the firm of Messrs. Smith (Holroyd), Baker & Co., of Manchester, and the earthenware insulators were manufactured and supplied by Mr. J. Slater Lewis according to the specification. This insulator was different from any ordinary telegraph insulator, for whereas in the latter the iron bolt supports the insulator, in the former the insulator supports the bolt to which the copper conductor is secured by a wooden pin. Iron and copper in contact in a moist sea water atmosphere! The insulator was fixed in a thick wooden board about a yard apart, with its extreme end exposed outside the wood to the earth. This end was unglazed, and the whole arrangement such as any practical telegraph engineer would at once disapprove of as unsuited for telegraph working; how much more unsuited would it be when the powerful currents to be used are considered!

It is needless to point out that these insulators, inserted in their places without having been tested, failed to give satisfactory results, and that the insulation resistance as given by Mr. Holroyd Smith some time after the line was working, was abnormally low. The report we inserted shows that all insulation has vanished, and that this line now only in its second year of working, has to be completely re-insulated before it can be again in proper electric working order. Having in this very short space of time gathered some very important experiences, it is to be hoped that the directors will profit by them and in future endeavour to carry out the working of the line under the management of some person who, in addition to common sense, will have some practical electrical knowledge.

LEGAL.

Edison and Swan Electric Light Company v. Shippey Bros.—In this case, which was before Mr. Justice Kekewich a fortnight ago, Mr. Arthur Shippey, it may be remembered, consented to judgment being entered against him in regard to certain lamps, it being agreed that execution should be stayed until the decision of the action which has been commenced by the Anglo-American Brush Corporation, Limited, against the Edison and Swan Company for infringement of Lane-Fox's patents. Mr. Shippey moved the court on the 10th inst. for a new trial, stating that certain facts had come to his knowledge, which, if he had known them at the time, would have withheld him from consenting to the order being made against him. In the course of his argument he stated that the case was commenced against him by the plaintiffs for infringement of certain lamps, and the restraining order was granted by Mr. Justice Chitty upon terms then agreed to by counsel on both sides upon the sworn evidence of Dr. Fleming and Chas. H. Gimingham as to two particular lamps, one of which was a "non-vacuum lamp," and the other an opaline reading lamp of low resistance, and upon which it was arranged he should keep the usual account. Neither of these lamps, he contended, were in any way infringements of the plaintiffs' rights, and this he should be able to prove by experts at the future trial. Judgment was obtained against him upon other lamps of French manufacture which were merely sold by his firm in the ordinary course of business; these were entirely different in construction from those upon which the action was based against him for alleged infringement. Mr. Justice Kekewich said: I cannot hear you now. What you are entitled to do is to move for a new trial on the grounds of mis-statement of facts or discovery of new facts, or such reasons as may occur to you, but that application must be made to the Court of Appeal and not to me. I have no power to grant you a new trial on any ground whatever. If you were to convince me at this moment that there had been a gross fraud even committed by them, I should still be obliged to tell you that I could not hear you. You must go to the Court of Appeal. The Court of Appeal may probably send you back to me.

NOTES.

The Electric Light at Bradford.—At the monthly meeting of the Bradford Town Council held last week, the chairman of the gas committee in answer to a question, stated that the committee had collected much information respecting the electric light, and he had hoped before then to have come to the council with a proposition for spending a sum of money to place down an extensive installation before the coming winter. Owing, however, to the immense amount of work in connection with the Jubilee celebrations that had fallen upon the Town Clerk's staff, the work had not been proceeded with so quickly as might have been desired. As it was now impossible to complete the scheme before winter, he recommended that it stand over, and the delay would enable them to take advantage of such improvements in electric lighting as might be introduced during the year.

Electric Lighting of the Carlton Club.—The committee of the Carlton Club has decided upon lighting the club throughout with electric light. The work has been entrusted to Messrs. Thompson, Ritchie & Co.

The Lighting of Winchester House.—We are glad to hear that the recent litigation between the Winchester House Company, Limited, and Messrs. Thompson, Ritchie & Co., for the cost of the maintenance of the plant, has been concluded, the Winchester House Company having paid the whole amount together with the interest and costs.

Electric Lighting at Weston-super-Mare.—Mr. H. G. Massingham, of Bath, has made arrangements for lighting Weston-super-Mare, including part of the new sea front, with the electric light from the middle of August till the corresponding period in September. As an experiment there was an electric installation at a recent promenade concert in the grounds of the Grove, when 30 arc lamps each of 1,200 C.P. were evenly distributed over the whole area and burnt brilliantly and steadily for several hours. There were nearly 3,000 persons present, who were highly gratified with the success achieved.

Long-Distance Telephones. — In the House of Commons on Monday, Mr. Jacob Bright asked the Postmaster-General if he was aware that there was communication by telephone between Hamburg and Berlin, between Rouen and Paris, and between towns widely distant from each other in the United States; whether his department had from time to time received representations from Manchester in favour of telephonic communication between Manchester and London; and whether he would take steps that what was done in other countries might also be done in England, to the advantage of the country. Mr. Raikes said he was aware that telephonic communication had been established between Hamburg and Berlin, Paris and Rouen, and between other towns on the Continent, and also in America. It also existed in this country, between London and Brighton and between Newcastle and the other Tyneside towns, as well, he believed, as between Manchester and Liverpool. The Post Office had not received representations from Manchester in favour of telephonic communication between that city and London. The United Telephone Company recently asked the terms on which the department would provide wires between London and Manchester; but up to the present time no answer had been received to the reply of the department. Having regard to the means of communication at present existing by means of the telegraph between the principal towns of the United Kingdom, he was inclined to doubt whether there would be much public advantage in establishing telephonic communication generally between towns at a great distance. It would be quite practicable, but there would be considerable expense in procuring a new way-leave. The telephonic wire could not be placed among the ordinary telegraph wires, owing to the interferences from the latter which would thereby be caused.

Undesirable Friction.—At the Dorchester Town Council last week the borough surveyor reported that the Western Counties and South Wales Telephone Company had established telephonic communication between certain premises without the permission of the corporation. The Town Clerk's opinion being that such leave was necessary, it was decided to serve the company with immediate notice to remove its wire.

A Public Convenience.—At Torquay the telephone company has recently, by way of experiment, opened three call rooms, where anyone can on payment of twopence speak to any subscriber to the exchange system in the town or at Paignton. Such a spirit of enterprise ought to be rewarded by the liberal support of the public.

An Æsthetic Town Councillor.—At Eastbourne Town Council last week, Mr. Chambers drew attention "to the disfiguring effect of the telephone poles," and contended that they should be constructed of iron, after an ornamental design, as was the case at Bournemouth and other places. The matter was referred to a committee for consideration.

The Telephone in North East Scotland.—We are glad to see, by the National Telephone Company's eleventh issue of its Dundee district subscribers' list, that the telephone is coming into greatly extended use in that part of Scotland. The list shows a substantial increase in the number of subscribers, and the accompanying map tells an eloquent story of enterprise on the part of the company. Perth, Dundee, Forfar, and Arbroath are all in direct trunk communication, a submarine cable across the Firth of Tay connects Newport and Tayport with the Dundee system, and another cable runs out to H.M.S. *Mars* in the Firth, connecting that vessel with the Newport exchange. Lines are projected to Brechin, Montrose, Aberdeen, and Inverness from Arbroath, to Kirriemuir from Forfar, and to Blairgowrie from Dundee. The day seems not far distant, indeed, when all towns of importance in Scotland may be put into direct telephonic communication with each other.

The Submarine Telegraph Company's Contract.—At a meeting of the Leith Chamber of Commerce last week a communication from the London Chamber of Commerce, stating that that Chamber had decided to advocate the non-renewal of the monopoly of the Submarine Telegraph Company on its expiry in 1889, was under consideration, and it was agreed to take the same action as the London Chamber. This Chamber held that it was anomalous to pay higher rates for telegraphic messages to the Continent than were paid for the transmission by submarine telegraph to various parts of the British Islands.

The Telegraph Staff.—In answer to Mr. Lawson, in the House of Commons last week, Mr. Raikes said he had received several petitions from various classes of the staff of the Central Telegraph Office, praying for alterations in the scales of pay, hours of duty, &c., and having given to them full consideration, he had found himself unable to grant the requests. He understood that a further petition would be placed before him in the course of a few days, and he should, of course, take the requests fully into consideration.

Electric Apparatus for Mine Firing.—The principal certified colliery managers of North Staffordshire have drawn up a memorial to the Home Secretary, calling attention to the necessity for preventing the use of gunpowder for blasting purposes in any ventilating district where gas has been found issuing, or to have accumulated within four months previously. The memorialists state that since the introduction of the gelatinous compounds and the water cartridge, with electric firing apparatus, not one single case of accident has occurred, although considerably more than 200,000 shots have been fired.

Manufacturing Cost.—The chairman of the Edison-Swan Company admits that he is not technical, but, he says, one does acquire, by applying common sense, a capacity for putting one's mind at ease. This is a very nice kind of feeling, and Mr. Forbes probably carries it as far as most people. That he is not technical, however, can readily be understood from the following remark of his respecting the manufacture of incandescent lamps:—"It was quite obvious that the man who had manufactured a million things could make them at a much cheaper rate than the man who manufactured only a quarter of a million." Other things being equal this may be the case, but surely if the man who manufactures the lesser number has better tools, a more economical system, and smaller managerial expenses, the worthy chairman's statement becomes less and less obvious?

Electric Lighting in Newspaper Offices.—At the meeting of the Edison-Swan Company last week, the chairman referred to the lighting of the *Times* office to show that electric lamps were a great boon in compositors' rooms. Mr. Forbes might have gone further, and mentioned the installations of the *Daily Telegraph*, *Standard*, *Morning Post*, and others in London, as well as several provincial ones.

Electrical Launches in America.—Mr. A. B. Frenzel, writing to the *Engineer* to correct a statement made by that journal as to the first use of electricity for boat propulsion in America, says:—"About three years ago there was constructed, at the works of C. H. Delemeter and Co., a monitor for submarine and surface torpedo duty under the patents of Mr. Tuck. The boat was equipped with storage batteries, charged from a dynamo, and the motive power was the stored electricity transmitted to the propeller shaft through a small dynamo. A high number of revolutions to the shaft was given, but the power was unsatisfactory, and is now replaced by improved machinery other than electrical. I personally christened the boat the *Peacemaker*, and ran her the first few trips she made. The Brush Company, of Cleveland, supplied the electrical equipment."

Weather Signals.—Prof. E. J. Houston has proposed a modification in the new code of weather signal flags recently adopted by the United States Weather Bureau. He suggests that the cold-wave flag shall be dispensed with entirely, and the indications of changes in the weather be shown by the position and distance apart of two flags only.

Fire Alarm Tenders.—We have been favoured with the following list of the tenders sent in for the erection of street fire alarms and electric communication throughout the district of the Hornsey Local Board:—Radcliffe, Birmingham, section A, £927; section B, £458; total, £1,385. Maintenance per annum, £100. Jennings, Lambeth, A, £760; B, £609; total, £1,369. Maintenance per annum, £35. Stuart, Twickenham, A, £829: B, £492; total, £1,321. Maintenance per annum, £75. Siemens, Westminster, A, £800; B, £500; total, £,1300. Maintenance per annum not stated. Sax, Bloomsbury, A, £755; B, £362; total, £1,117. Maintenance per annum, £80. Telegraph Manufacturing Company, E.C., A, £725; B, £362; total, £1,087. Maintenance per annum, £100 to £120. Blackburn, Nottingham, A, £660; B, £340; total, £1,000. Maintenance per annum not stated. Reid Bros., Wharf Road, N., A, £702; B, £290; total, £992. Maintenance per annum not stated. Sharples, Preston, A, £649; B, £340; total, £989. Maintenance per annum, £90. Nelson, Leeds, A, £616; B, £356; total, £972. Maintenance per annum, £60. Theiler, Canonbury, A, £640; B, £300; total, £940. Maintenance per annum, £120. Eidsforth and Mudford, Holloway, A, £577; B, £320; total, £897. Maintenance per annum, £42. India-Rubber, &c., Company, Essex, A, £550; B, £260; total, £810. Maintenance per annum, £86. Fowler, Lancaster & Co., Birmingham, A, £389; B, £205; total, £594. Maintenance per annum not stated. Robertson and Sunderland, Halifax, A, £393; B, £170; total, £563. Maintenance per annum not stated. Blenheim, Egham, A, £276; B, £144; total, £420. Maintenance per annum, £10. (Accepted.) Exchange Telegraph Company, B, £376. Maintenance per annum, £36. Durham, Stockport, £500 for fixing telephones only.

The Crown Prince of Germany.—It would appear from the medical journals that the only treatment used by Dr. Morell Mackenzie in the case of his illustrious patient is electricity, a galvano-cautery battery improved and perfected by Mr. Thistleton, of Old Quebec Street, W., being employed. Dr. Mackenzie appears to be sanguine of success, and has sent the Prince to Scotland for the benefit of the air, and in order to guard against accidents a second complete battery has been supplied by the same electrician.

British Association.—At a meeting of the Newcastle-on-Tyne Literary and Philosophical Society last week it was decided that steps should be taken to invite the British Association to hold its 1889 meeting in Newcastle. Lord Armstrong, Sir Lowthian Bell, and others connected with the district, wrote approving the proposal.

The Accounts of the "Inventions" Exhibition.—A statement of the receipts and payments, from August 12th, 1884, to July 20th, 1887, of the International Inventions and Music Exhibition, 1885, has just been issued. It is signed by the chairman and secretary of the Executive Council, and has been audited by Messrs. Lovelock and H. W. S. Whiffin, chartered accountants. The total sum received was £214,403, of which £149,826 was from admissions, £15,517 from the Health Exhibition, and £2,574 from the Colonial and Indian Exhibition. The whole of the receipts were spent, the chief items of expenditure being—buildings, £30,778; working of electric exhibits and electric lighting (exclusive of gardens), £37,532; garden illuminations, £9,214; water gardens and illuminated fountains, £3,107; motive power (machinery exhibits), £14,848; wages, 18,845; publications, £10,830; advertisements, £14,971; and music, £17,039.

Festivities.—The annual outing of the electrical and engineering staff of the Royal Courts of Justice took place on Monday the 15th inst., when they, with several friends, proceeded in a reserved carriage by the S.W.R. to Egham. Amongst those invited were Mr. A. Grundy, of Baily and Grundy (late electrician at the Courts and the originator of these outings), Mr. Madders, engineer of the Orange Street Waterworks, Mr. Shurman, engineer to the Law Land Co., and others. On arrival at Egham, after refreshments had been partaken of, sides were drawn for and a match at cricket was played. At the dinner which was served at the "Barley Mow," Mr. Grundy was (in the absence of Mr. Palfreeman, chief engineer) voted to the chair. Various toasts were heartily drunk, and then the party adjourned to the river where several interesting rowing matches were decided, and a commemorative group was photographed. Tea being disposed of the party returned to town very tired, but very happy, a most enjoyable day having been spent by all.

The annual excursion and dinner of the *employés* of the Anglo-American Brush Electric Light Corporation came off with great *éclat* on Saturday, August 13th. The party, numbering nearly 100, left London Bridge at 6.45 a.m. and reached Littlehampton at 9 o'clock. Boating and bathing were freely indulged in, and all made the best of the time at their disposal. At one o'clock the party adjourned to the Terminus Hotel and partook of a splendid spread. The chair was taken by Mr. E. Garcke, managing director. Toast and song followed, and a very enjoyable time was spent.

Thunderstorm.—A terrific thunderstorm burst over London on Wednesday evening, but no great amount of damage was done, nor have we heard of injury to any person or loss of life. In Birmingham, where the storm raged earlier in the day, two men were struck by lightning and killed. One or two curious incidents are recorded. The *Times* speaks of one flash of lightning emitting thousands of small fireballs like the shower from a sky-rocket. Was this the much doubted globular lightning? During the height of the storm the "Pine Apple Tavern," Leverton Street, Kentish Town, was struck. The cornice of the house is surmounted by two or three large pine apples modelled in cement. The lightning struck one of these, and with a terrible report blew it to pieces. The current then passed to a bell wire, and at the various points of resistance disintegrated the metal and blew out the wall plaster over the rooms. The current then passed to the spirit pipes, splitting them, and finally went to earth in the cellar. The alarm in the neighbourhood was very great, and it is a fortunate circumstance that no person was passing when the brickwork and pieces of cement were falling.

Electric Railways and Passenger Duty. — The Chancellor of the Exchequer, replying to a question from Mr. Picton in reference to Volk's Brighton Electric Railway on Tuesday, said it was not exactly correct to say that railways on public roads were "exempted" from passenger duty; but it was held by the Inland Revenue Department that they were not liable to passenger duty. There was no "exemption," because such railways did not fall within the legal definition of railways proper, and, therefore, they were not liable to passenger duty. They were liable to duty in another form, because by Clause 7 of the Customs and Inland Revenue Act, 1883, any vehicle drawn or propelled by steam or electricity was subject to carriage duty.

Atlantic Cable Rates.—The *Standard* says it seems highly probable that the tariff war between the Anglo-American Cable Companies will be prolonged for some time yet. The Commercial Cable Company has announced its determination to reduce its tariff from one shilling to sixpence per word, unless the other companies consent to a compromise before the end of the week, and charge in future one shilling and eightpence per word. Negotiations between Mr. Mackay and the Western Union Company have been going on for some time past, but from this announcement it may be presumed they have been entirely broken off. It seems that the Western Union and the other companies in the pool have made up their minds that a tariff of less than two shillings per word would be unprofitable to their shareholders, whilst, on the other hand, Mr. Mackay has strong reasons for not raising the charge to higher than one and eightpence per word. Were he to do so, he would have to refund a large sum of money to his customers under a guarantee he gave at the commencement of the war. He then promised to refund sixpence per word—that is the difference between his rate and that charged by the associated companies—should he be compelled at any time to raise his tariff to over one and eightpence. The bone of contention in the recent negotiations between Mr. Gould, as representing the Western Union Company, and Mr. Mackay appears to have been the question who should meet the claims of the Commercial Company's customers if the tariff were raised to two shillings. Mr. Mackay thinks that the associated companies should be the sufferers, but the latter naturally take an opposite view. The deadlock is, therefore, serious. Mr. Mackay has no shareholders' interests to consult, and there is no saying to what lengths he may carry the fight.

The Eclipse Battery.—Has anyone ever seen this battery as applied to omnibuses in action longer than nine hours? If used for three hours, say to-night, and then left over till to-morrow night, would it not run down at an enormous rate? Is not the stench from the cells very noticeable? Are not the zincs amalgamated every time the battery is charged? Has a battery ever been known to satisfy the demands of omnibus lighting for two nights in succession without attention? Did not one of these batteries quite recently "explode" blowing cells and box all to pieces, and does not this discount the utterances of Prof. Silvanus Thompson relative to its mining merits? Does not the cost of charging one pair of batteries as used in a road car, *i.e.*, two boxes comprising four cells in each box, amount to 8d. or 9d. for sulphuric acid, nitrate of soda, and amalgamated zinc.

Electric Light and Army Signalling. — Traction engines with trains of cars, in charge of Royal Engineers, arrived in the camp at Lydd on Monday from Chatham, laden with steel cylinders filled with compressed gas for experimental ballooning, which is to take place on Dungeness beach. Besides these cylinders apparatus for experimental electric light flashing was taken down in the road cars from Chatham by the Royal Engineers.

The Oerlikon Dynamo.—As showing the durability in working and freedom from overheating of this new dynamo, it is stated that in an electro-metallurgical establishment near Turin, five Oerlikon (Brown's) dynamos are running day and night each with their full load of 50,000 watts, and with only an interval or stoppage of five minutes in the 24 hours, without becoming overheated. None of the dynamos hitherto tried for this work would do this.

Telegraphists' Athletic Sports.—The annual meeting of the Electric Athletic and Cycling Club, which is composed of members of the staff of the Central Telegraph Office, takes place at Stamford Bridge on Saturday next. Over 200 entries have been received, and a start will be made at 3.30. Mrs. Barlow, wife of the Sub-Controller, will distribute the prizes.

The Telautographe.—The Paris correspondent of the *Morning Post* says that a new invention, called the telautographe, has been exhibited there, by means of which any kind of document can be reproduced by telegraph in the handwriting of the sender. The first experiments gave most satisfactory results. This is probably the apparatus of Prof. Gray, of America, but who is exploiting it in Paris? Perhaps Dr. Cornelius Herz!

Cheap Telegraphy.—Mr. Sinclair asked the Postmaster-General on Friday last as to the establishment of a system of night, or half-rate, telegraph messages, if, considering the facilities afforded to the Press for the transmission of long telegrams, he was prepared to make any concession to individuals and private firms desirous of sending telegrams of considerably more than the average length. Mr. Raikes said it would be very undesirable at the present time to make any alteration in the tariff for telegraphic messages. So comparatively short a period had elapsed since the present tariff came into operation that the financial result of the change could not at present be ascertained with certainty.

NEW COMPANY REGISTERED.

Schanschieff Electric Battery Company, Limited.—Capital £25,000 in £250 shares. Objects: To adopt an agreement of the 8th inst. for the purchase of patent rights relating to improvements in galvanic batteries and in saline and other preparations for use in connection therewith; for improvements in miners' safety lamps and in galvanic batteries for use with the same; and for an invention for enabling miners to detect the presence of fire damp. Signatories (with one share each):—David Marks, 4, Cornwall Mansions, South Kensington; L. H. Samuel, Bushey; S. Hoffnung, 102, Fore Street; S. de Lissa, 18, Queen Victoria Street; H. A. Trower, Goring-on-Thames; Henry Eskell-Paget, 58, Ludgate Hill. Messrs. David Marks and Alexander Schanschieff are the first directors. Qualification one share; the company in general meeting will appoint remuneration. Registered 10th inst., by F. H. Harvey Samuel, 1, Whittington Avenue, Leadenhall Street.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

African Direct Telegraph Company, Limited.—The annual return of this company, made up to the 4th inst., was filed on the 9th inst. The nominal capital is £300,000 in £10 shares. 22,500 shares have been allotted, and the full amount has been paid thereon.

Cadogan Electric Light Company, Limited.—The statutory return of this company, made up to the 4th inst., was filed on the 10th inst. The nominal capital is £6,000 in £5 shares. 196 shares have been taken,

and £3 per share has been called up, the calls paid amounting to £170 10s., and unpaid to £12 10s. The total amount received on shares fully paid is £675. Registered office, 137, Regent Street.

South of England Telephone Company, Limited.—The annual return of this company, made up to the 26th ult., was filed on the 10th inst. The nominal capital is £400,000 divided into 300,000 ordinary shares of £1 each and 20,000 preference shares of £5 each. The whole of the ordinary shares are issued and are considered as fully paid. 16,423 preference shares are allotted and £1 10s. per share has been called up, the calls paid amounting to £24,574 10s. and unpaid to £75.

Kay Brothers, Limited (chemists and dealers in electrical, surgical and scientific apparatus).—The statutory return of this company made up to the 8th June was filed on the 15th June. The nominal capital is £100,000 divided into 9,990 ordinary shares of £10 each and 100 founders' shares of £1 each. 7,120 ordinary and 100 founders' shares have been allotted and are considered as fully paid. Registered office St. Peter's Gate, Stockport, Chester.

J. G. Statter and Company, Limited (electrical and general engineers).—An agreement of 29th ult. provides for the allotment of 590 shares to Mr. John Grice Statter, and 50 shares to Mr. Sidney Linton Brunton, in pursuance of an agreement of 30th April. These shares will be issued with the full amount of £10 credited as paid up.

Wynne's Electric Closed Tube Tramways Company, Limited.—The registered office of this company is situate at 5, Westminster Chambers, Victoria Street, S.W.

Eclipse Electric Battery Company, Limited.—The registered office of this company is situate at the White House, Telegraph Street, E.C.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th August are £1,998, as compared with £1,676 in the corresponding period of 1886.

NEW PATENTS—1887.

10716. "Electric coverings for indicating abnormal conditions." T. M. KNIGHT. Dated August 4. (*Complete.*)

10740. "Regulators for electric lamps." S. MATHIS. Dated August 4.

10748. "Portable batteries for producing electric light." A. SCHANSCHIEFF. Dated August 4.

10749. "Membrane diaphragms for telephones." R. A. LEE. Dated August 4.

10767. "Measuring electric currents and for regulating and controlling dynamo-electric machines and prime movers." W. LOWRIE and others. Dated August 5.

10773. "Silencing noise or vibration on telephone, telegraph or other overhead suspended wires, &c." W. JAMIESON. Dated August 5.

10833. "Electric lamps." F. R. BOARDMAN. Dated August 6.

10834. "Galvanic batteries." A. R. UPWARD, C. W. PRIDHAM. Dated August 6.

10836. "Electrical firing mechanism for ordnance." C. A. McEVOY. Dated August 6.

10838. "Electrical switches and tools for forming parts of same." F. L. RAWSON, W. WHITE. Dated August 6.

10850. "Switch or contact maker for electric light circuits." A. J. SHIRLEY. Dated August 8.

10872. "Battery connections for telegraphic and telephonic lines." J. IMRAY. (Communicated by C. Clamond.) Dated August 8.

10909. "Cash and package carriers." H. J. HADDAN. (Communicated by L. G. Bostedo.) Dated August 9. (*Complete.*)

10919. "Plates for secondary batteries." E. JONES. Dated August 9.

10933. "Insulating electric currents." D. S. ROBERTSHAW, R. S. SUNDERLAND. Dated August 10. (*Complete.*)

10952. "Dynamo-electric machines." L. AUSPACH, L. GERARD. Dated August 10.

10963. "Instruments for the measurement of electromotive force and power." J. A. FLEMING, C. H. GIMINGHAM. Dated August 10.

11004. "Apparatus for the electrical propulsion of electrical tramcars, &c." M. H. SMITH. Dated August 11.

11054. "Communicating by electricity between trains and between trains and stations." L. J. ALBONY. Dated August 12.

11067. "Electric railways." J. M. V. MONEY-KENT, S. SHARP. Dated August 13.

11091. "Friction couplings governed by electricity." J. S. RAWORTH, H. M. SAYERS. Dated August 13.

11114. "Electric apparatus or arrangement for lighting cigars, &c." E. E. ATKINS. Dated August 15.

11129. "Electro-magnetic telephones." H. COLLET. Dated August 15. (*Complete.*)

11151. "Electric arc lamps." J. L. WOLFGANG. Dated August 15.

11167. "Electrical differential dial indicator for telegraphic and telephonic purposes." J. KELMAN. Dated August 16.

11181. "Printing telegraphs." J. H. LINVILLE. Dated August 16. (*Complete.*)

11188. "Converting chemical energy into electrical energy." H. H. LAKE. (Communicated by W. E. Case.) Dated August 16. (*Complete.*)

11189. "Converting heat into electrical energy." H. H. LAKE. (Communicated by W. E. Case.) Dated August 16. (*Complete.*)

11200. "Electrical motors." A. J. BOULT. (Communicated by J. F. McLAUGHLIN. Dated August 16. (*Complete.*)

11209. "Apparatus for the conveyance of cash, memoranda, or goods from one part of a shop, &c., to another part thereof." J. C. MARTIN. Dated August 16. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

7107. "Improvements in holders for incandescent electric lamps." R. A. SMITH. Dated May 27. 8d. Claims:—1. A lampholder, in which two earthenware, or other non-conducting incombustible, parts, containing an insulated metallic piece, forming one terminal of the lampholder, are attached to an external metallic piece by means of screws or rivets passing through the said non-conducting incombustible parts and screwed or riveted into the external metallic piece; the said external metallic piece forming the base-plate by which the holder is attached to the fitting and also the other terminal of the lampholder. 2. A lampholder, having two earthenware, or other non-conducting incombustible, parts, one of the said parts having a cylindrical tubular projection fitting into a corresponding annular recess in the other part; the arrangement being that commonly known as a spigot and faucet joint, substantially as and for the purposes described. 3. The improved incombustible lampholder as a whole substantially as described and shown.

7806. "An apparatus for producing intermittent electric light." P. JENSEN. (Communicated from abroad by K. Pollak and G. Wehr, both of Berlin.) Dated June 10. 8d. Claims:—1. An apparatus for intermittent electric lighting, consisting of the combination of a clockwork apparatus with a contact by which the clockwork when wound up is released by the electromagnets, that is to say, set in motion, a contact being effected at the same time, whereby the electric current is closed for the lamps until the clockwork automatically interrupts same, substantially as described. 2. An apparatus for intermittent electric lighting, consisting of the combination of a clockwork apparatus with a contact by which the clockwork is wound up every time and set in motion by an electric current or by mechanical means whereby the electric current for the lamps is closed until the clockwork interrupts same automatically, substantially as described. 3. The construction of apparatus for intermittent electric lighting, substantially as described and shown.

8588. "Improvements in regulating mechanism of electric arc lamps." F. C. PHILLIPS and H. E. HARRISON. Dated June 30. 8d. A ring lever and two pieces are used one inside the ring lever and the other outside thereof together with a step or projection whereby the ring lever may be moved and tilted in a plane containing the said two pieces. These two pieces constitute parts of a plunger arrangement, and when the ring lever is actuated by the step as above mentioned, it operates to press the two pieces apart so as to cause them to bear against and take a hold of the hollow carbon holder. An arrangement of this kind (when the hollow carbon holder used is a tube of circular cross section which may be connected in any convenient manner to the carbon holder proper) comprises a cylinder reduced in diameter in its central part so that when the ring lever is placed on to and over this reduced part, the cylinder and ring lever move freely inside the hollow carbon holder. The largest diameter of the ring lever must be somewhat less than the internal diameter of the hollow carbon holder. A piece is provided which shall when in place fit between the inside of the hollow carbon holder and the outside of the ring lever. The ring lever is a short hollow cylinder; thus if the side of the ring lever opposite to the piece be moved or tilted so that the axis of the ring lever is no longer co-incident or parallel with that of the cylinder, the one piece will be pushed against one side of the hollow carbon holder, and the cylinder which constitutes the second piece against the other side, and if the step be further moved the clutch and hollow carbon holder will move with it. The claims are 3 in number.

8832. "A novel saline preparation applicable for use in galvanic batteries and the process for the manufacture of the same." A. SCHANSCHIEFF. Dated July 6. 6d. Claims:—1. A novel saline preparation composed of mercury and sulphuric acid forming a salt freely soluble in water to such a degree that two pounds or thereabout of metallic mercury may be held in solution in a gallon of water. 2. A novel saline preparation or solution composed of mercury, sulphuric acid, and water so combined, substantially as described, that the water may hold in solution one-fifth of its weight or thereabout of metallic mercury. 3. The process for the production of a novel saline preparation consisting in dissolving mercury in sulphuric acid, evaporating the excess of acid, adding water to the resulting mass and separating the precipitate then treating this precipitate with acid and again with water, and so on, substantially as described, and either retaining the solution for use in the liquid form or evaporating the solution to obtain the solid salt. 4. The process for the production of a novel saline preparation consisting in dissolving mercury in sulphuric acid, evaporating the excess of acid, adding water to the resulting mass and completing the solution by the gradual addition of strong sulphuric acid, substantially as described, and either retaining the solution for use in the liquid form or evaporating the solution to obtain the solid salt.

8995. "Improvements in telegraphic alphabets." W. L. WISE. (Communicated from abroad by J. Rae and J. C. Simpson, both of Montreal.) Dated July 9. 8d. The letters of the alphabet are divided into groups, each group being denoted by a distinct sign or combination. For instance, the first group can be indicated by a single mark, the second by two marks, and so on. Each letter of the group will be indicated by a distinct sign or combination, such as one mark for the first, two marks for the second, &c., &c., the sign indicating the letter being always separated from that showing the group by a defined space. Figures, marks of punctuation, &c., may be indicated in a similar manner. The claims are 3 in number.

9096. "Improvements in the construction of dynamo-electric machines." W. MAXWELL. Dated July 12. 6d. Claims:—1. In the construction of dynamo-electric machines, winding the armature with two conductors or two sets of conductors, the one applied to excite the field magnets and the other to supply the external circuit, substantially as and for the purpose herein set forth. 2. In the construction of self-regulating dynamo-electric machines, winding the armature with two conductors or two sets of conductors, the one applied to produce the magnetic field and the other to supply the external circuit, and also to regulate or control the magnetic field of the machine, substantially as described. 3. In the construction of dynamo-electric machines, winding the armature and also the field magnets with two sets of conductors, substantially as and for the purposes set forth.

CORRESPONDENCE.

Elieson's Electric Locomotives.

Referring to the note in your issue of the 5th inst., it fell to my lot to run the first electric street-tramcar in England, and that the fact of my having through various incidents and circumstances, arranged with the North Metropolitan Tramways Company for that first run on their line (which has no doubt been the initial cause of that company being the first to apply for electric traction powers), I have I think a peculiar title to offer the following observations:—

A few days ago, I went as an ordinary passenger on the Stratford and Manor Park Tramways, and saw two of Mr. Elieson's locomotives in steady and methodical operation. I there saw the *first and only instance in this country of the actual practical operation for every-day tramway work of electric traction by accumulators.*

Now, Mr. Elieson has met with a good deal of criticism, and his methods of detail have been freely attacked; but what I want to point out is (what I feel sure will be generally and fully recognised on reflection) that Mr. Elieson deserves the thanks and hearty support of electrical men generally, as there is no doubt that the potentiality of individualism which he has brought to bear in getting a great deal of hard initial work carried out, has greatly in its effects helped forward electric traction in the metropolis, quite regardless of the particular methods employed.

Even if he never ran his engines another mile, the effect of his work would remain, as having greatly helped forward electric traction, and I, for one, recognising this, heartily hope that an ample share of the enormous amount of electric traction work to be done will reward Mr. Elieson and those who have done good and lasting help to the work in supporting him.

I feel sure these views will meet with your approbation.

Radcliffe Ward.

August 17th, 1887.

Incandescent Lamp Patents.—Edison and Swan *v.* Shippey Brothers.

As you have commented upon this case, and as the legal report contains but a brief account of the real facts, perhaps you will allow me a small space to explain a few points in connection with this matter. In the first place, the case came on very suddenly, and almost, I may say, mysteriously. It was not expected to be in the list for trial until after the vacation, and an enquiry is now being made as to why this could be done, as the solicitors for the plaintiffs only a few days previously asked my then solicitors for time in consequence of the absence of Sir F. Bramwell, which delay I consented to, in good faith, but it is evident now that this was only a ruse to put me off my guard, so as not to be ready to fight the case on its proper footing. Notice was only sent to my offices at 5.40 to say the case was second in the list for the next morning; you can imagine my surprise on receiving this notice.

I had arranged to produce 32 British and foreign witnesses on my side, including some of the leading men of the day, and scientific experts in lamp-making, who would have entirely disproved the evidence produced by the plaintiffs, but it was impossible to call them together during holiday times at a moment's notice. I had only time to subpœna Mr. Swan and a few others, who were in attendance. Finding my solicitors had not got briefs prepared for counsel, I had no alternative (although reluctantly) but to conduct my case in person to the best of my ability in the unfortunate position in which I was so suddenly placed.

I appealed to the judge to let the matter stand over until next term, and I have no doubt he would have consented, but Mr. Aston, counsel for the plaintiff company, standing on his legal rights, urged for the case to go on. Under these circumstances the judge was compelled to allow it to proceed, and the array of counsel brought against me only shows what money can do, and may be termed as a case of Might *versus* Right. I say right, because if the trade will only rally round and support me I will yet disprove the unwarrantable charge made against me of alleged infringements, and if I do this a monopoly of the lamp trade will be frustrated, which in the interest of electrical science is the object I have in view.

It is true I have apparently lost the case on one point, but I have gained it in two; therefore, my position is stronger, and my firm can still supply (as the judge stated) certain lamps which do not contain lampblack and tar or fibrous carbonised filaments, which I have no wish to sell, especially as I can produce a more brilliant effect from my new semi-metallic conductors at a reduction in price. I have decided to make an application for a new trial. If I succeed on this point I may yet recover lost ground and avoid the heavy costs incurred; if not, the trade will be put in possession of certain facts at present unknown.

Fortunately for users of incandescent lamps the war has only just commenced, and my case is only a preliminary scrimmage to the great battle about to be fought in the pending Lane-Fox case, which Mr. Lane-Fox assured me in court would be carried out. This at once convinced me that discretion would be the better part of valour. I, therefore, decided to offer no rebutting evidence, but reserve it for a future occasion, resting quite content for the moment on the work I have done so far by my cross-examination of the plaintiffs' witnesses in bringing out certain facts.

As I have already intruded largely on your space, I must conclude, and in the meantime I must ask your readers to suspend their judgment as to the merits or

demerits of the case until they have perused the evidence and facts which I shall produce on a future occasion.

Arthur Shippey.

August 11th, 1887.

Having heard all the evidence given in the recent case of the Edison and Swan Company *versus* Shippey, I cannot but regret that the evidence was not published *in extenso*, as it conveys a lesson which the public would do well to profit by. I am very strongly of opinion that the experts who gave their evidence for the Edison and Swan Company never proved their case at all, and I am also morally certain that if Mr. Shippey had been represented by counsel this would have been clearly shown. By the evidence of the experts it was attempted to show that the two lamps produced in Court, and upon which, as Mr. Justice Kekewich clearly pointed out, the whole case turned, were lamps containing carbon filaments in a globe containing a vacuum.

Two very natural questions seem to suggest themselves here, viz.: What is a carbon filament, and what is a vacuum? The replies given to the questions asked in the cross-examination seemed to show a very laudable anxiety to stretch these terms to a very much broader sense than the definitions of either carbon or vacuum would seem to warrant. One thing I am perfectly convinced of, that the experts never proved conclusively either that the filament was carbon or that the globe contained a vacuum, simply because they never applied a proper test at all, which would be satisfactory proof to a chemist of the facts they were anxious to demonstrate.

To test the filament for carbon they simply dropped it into a red hot crucible and blew air on it. They never weighed the filament to see what percentage of carbon it contained, but when in the crucible and red hot they *did* blow air on it, which current of air, *however gentle, must* have have removed the ash as fast as it was formed, if of a flocculent nature. As a proof of this, in some other filaments Professor Dewar found some ash. In cross-examination one of the experts was asked if a filament saturated with tetra-chloride of platinum and then subjected to further treatment would be a carbon filament. In the course of his reply he stated that that the body of the filament would be pure carbon. Now I know from experience that this is absolutely and entirely wrong. The filament absorbs the platinum tetra-chloride, and on heating, spongy platinum is left in the body of the filament. Such an answer is misleading, and shows either ignorance or gross carelessness.

In testing the lamp for vacuum by the induction coil *a glow discharge was obtained similar to that in a Geissler's tube.* This, too, *whilst the lamp was cold*, which it ought in fairness not to have been for this test. In applying the mercury test the lamp was also tested cold, and it was admitted that the mercury might have *contained occluded gases.* This shows that the most ordinary precautions were not observed.

The same expert went on to say that the vacuum might have been *better* than that indicated, *but certainly could not have been worse.* Surely he cannot have been ignorant of the fact that gas condenses on the surface of glass, unless the glass is heated for some time, and that consequently the bubble left in the globe (which he said indicated an exhaustion to the 400th of an atmosphere) could not have been the correct measure of the amount of exhaustion in the globe. This is why I maintain the lamp ought to have been tested for vacuum whilst hot. I may mention that I am an electrical engineer by profession, but I am also a chemist, and as such am accustomed to a considerable degree of accuracy in experimental work, and I must confess, and I feel confident that other chemists will endorse what I say, that I should have been ashamed to perpetrate such a number of grave errors over one experiment.

I am strongly of opinion that a man cannot be an expert in everything, and that he should not undertake that which he is incompetent to perform. I do not mean to say these experts were incompetent to do the work they undertook, but I do mean to record my opinion, which is that these tests (if I may dignify them with such a name) were not performed in a competent manner.

I am also of opinion that no sane man could make oath as to the composition of the filament or the amount of exhaustion of the globe by such carelessly-conducted tests. I wish, therefore, to record my protest in the interest of the public. I may add that one of the experts would not state that the filament *was* carbon, but only that he was of opinion that it was.

W. Hamilton.

Breakdown of Motor Armatures.

In your issue of the 5th inst. you speak of the breakdown of the electric locomotives at Stratford. It is not an uncommon thing for the prolongations of the coils to break, but it does not as a rule take *several weeks* to repair them, and certainly it does not require a new armature altogether.

The breakdown I cannot help thinking must be from some other cause, and especially as the new armatures are made by a new firm.

W. Danton.

Photograph of the Arc.

I enclose you a scientific curiosity, viz., a photograph of the "arc" of an arc lamp taken about 16 inches from the carbon points whilst burning with a current of 20 ampères. I am not aware that this has ever been done before. The "blurs" are the small

flames. The method employed was to pass the rays through a pair of Nicol's prisms turned in respect to one another till the light was sufficiently moderated. Time of exposure, 4 seconds; intensity = 128 Dallmeyer standard. You are at liberty to publish the photo and description should you desire to do so.

D. S.

The "Eclipse" Primary Battery.

The letter, dated March 23rd, 1887, which you print on page 168 is imperfect in one respect; the original was marked "private"; and, indeed, as must have been obvious from its contents, it was never intended for publication. I have received from Mr. Walsh, under date August 10th, a tardy and lame apology, couched in the following terms:

"Dear Sir,—As you have called attention to the statement current in the public press that you have made a *report* on the 'Eclipse' battery, I beg to state that you sent me a private letter, a copy of which seems to have got into other hands. I must express my most sincere regret that this should have occurred,

"Yours faithfully, J. J. WALSH."

As Mr. Walsh admits that the letter was private, I have no need to enter upon its contents, and will leave to others to characterise in adequate terms the use that has been made of it.

Silvanus P. Thompson.

August 15th, 1887.

A Standardising Laboratory.

I have shown in my letter last week that there are really two distinct problems to be solved before reliable measuring instruments can be made. The first is a mechanical problem, namely, to divide the scale of an

instrument in accordance with its true law. This is purely a matter for the makers, and is one to which they will have to devote a great deal of attention before a really satisfactory solution is obtained.

The second, and by far the easier problem, is to ensure every maker starting from the same standards. This can be secured by a standardising laboratory to which instruments and standards can be sent for verification. Standards should, of course, be issued from the laboratory. It seems to be generally assumed that we have only to get the authorities at Kew, for example, to undertake this work in order to have all we desire; (the word "Kew" is apt to inspire something of the reverence felt by the old lady for the "blessed word Messopotamia") but it should be remembered that the work so ably carried on by Mr. Whipple has been confined to the simplest of measuring instruments, the standards for which are easily verified.

It has been suggested that instrument makers should themselves provide and maintain a standardising laboratory, where subscribers could have their instruments verified free of charge; outsiders and the public paying fees for verifications. Given a well found laboratory, a good income, and an awe-inspiring committee of management, where are we to find a trained observer as director who would command general confidence and never make a mistake? The success of the whole scheme depends on that more than mortal man.

The usual methods of standardising are capable of great accuracy, but unfortunately they sometimes give very fallacious results even in careful hands; let me illustrate this by an instance within my knowledge:—A person whom, following Sir Thomas Bazley's excellent notation, we will call K., had a standard Clark cell which, measured by his standard, was 1·434 volts. A little suspicion having been cast on the cell, X. offered to check it against his own standards. He did so and reported its value as 1·423; K., like everyone else, believed in X., and promptly returned the cell to the makers (Z.) for verification; Messrs. Z., out of pure generosity, re-charged the cell and when returned, its E.M.F. in K.'s units was 1·465!! K. now hunted for a man who was independent of X. (X. has such a reputation that it was not easy to find one); however, Y. appeared to satisfy the necessary conditions of skill and accuracy and was certainly not $= f(x)$. Accordingly the unhappy cell was handed over to Y., who found its value to be 1·466. If these different values are worked out we find the following relative values of the volt in terms of K.'s volt.

Authority.	Value.
X.	1·0077
Y.	·9993
Z.	·9790

This little affair shows very clearly the urgent need for, and one of the dangers of, a standardising laboratory. The need is apparent; the danger lies in this: both X. and Y. would be considered as eminently fitted to be directors of such an institution (probably Messrs. Z. would be chosen to construct the apparatus). Had Y. or X. been armed with Government or other authority, the reputations of either X. or K. and Y. would have been unjustly blasted. As it is, each is ready to swear he is right.

Sydney Evershed.

August 16*th*, 1887.

Platinoid.

Your correspondents, the London Electric Wire Company, do not seem to grasp what Mr. Weston or Mr. Prescott has done. That Mr. Weston failed to produce a tungsten alloy is most probable, but that is not the point, as whether Mr. Weston made a tungsten alloy or not he produced a number of alloys without tungsten, and found that those with a large proportion of nickel had a high specific resistance and a low temperature coefficient, and that by making a German silver with a large percentage of nickel he got the electrical qualities claimed for platinoid. I see no reason whatever to doubt Mr. Weston's figures.

Mr. Bottomley's tests were nearly all electrical, and neither Mr. Weston, Mr. Prescott, nor myself have ever doubted their accuracy. I have tested five samples of platinoid wire obtained from your correspondents, and have failed to find any traces of tungsten in any of them. These were dissolved in pure nitric acid diluted with about its volume of water. There was in one sample a mere trace of some white powder left, but it seemed to be metastannic acid or antimony oxide, and it did not blacken when treated with stannous chloride. Even if there were tungsten in it I can hardly imagine that it would increase the density, and cannot see what the density has to do with the wires not tarnishing.

While differing from your correspondents in matters of pure science, I must say that I think electricians are very much indebted to them for the introduction of platinoid, whether it contains tungsten or only a high percentage of nickel. It is invaluable for many purposes, and the wire is very beautifully even, resistances of a hundred feet or so coming right within a few inches.

Jas. Swinburne.

August 16*th*, 1887.

Blackpool Electric Tramway.

Seeing in your issue of the 5th inst. a reference to the above, and having recently examined the line on behalf of the tramway company, perhaps a few remarks may not be out of place.

The expansion of the copper tubes referred to has also had another, and, perhaps more serious result, viz., the cracking of the insulators themselves.

This is owing to the skids connected with them being firmly keyed to the tube, and consequently participating in the motion caused by the expansion of the same.

In the design (?) of the insulators no arrangement has been made to keep a dry surface, or to prevent the creeping of the pitch, mud, &c., which runs down the side of the channel, and in many cases extends over the surface to the iron studs themselves, thus affording a ready path for the leakage of the current. The channel, being so narrow, offers great obstacles to the employment of a properly-designed insulator.

I took the trouble to test a number of the insulators, both new and old, and found that with the full E.M.F. employed there was no leakage through the mass of the insulator, even after soaking for 24 hours in acidulated water, and with the glaze chipped off in some cases, thus proving the material employed to have been of good quality.

The amount of loss on the line varies from 25 to over 100 ampères at the E.M.F. of 250 volts.

F. Bryan.

August 11*th*, 1887.

I notice that in his letter Mr. J. Slater Lewis states as regards the insulators used on this line, "although I had my opinion as to their practicability, it was not my business to interfere." This is, of course, *after* the event. But I think Mr. Lewis's opinion may very fairly be judged of these insulators, by the fact that every insulator was stamped "J. Slater Lewis, Birkenhead, Eng." It is known that the insulators were not tested after delivery; were they ever tested after manufacture?

In the new form of insulator about to be made, it would be found desirable to have those portions in contact with the earth glazed instead of unglazed as in the first form. It would be also desirable not to have the bolt fixed nearly through the insulator. At all events, it is to be trusted that it will be an "insulator," and test accordingly. "Experientia *should* docet."

Manchester.